

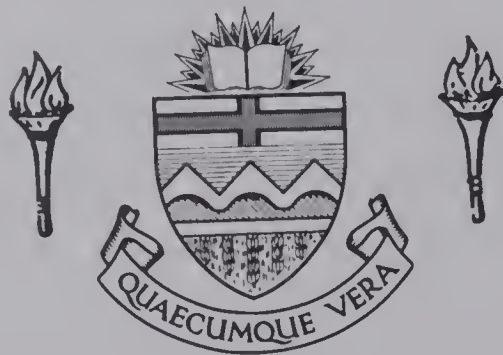
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AN ECONOMIC CRITIQUE OF THE
COLUMBIA RIVER TREATY AND PROTOCOL

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF ARTS

DEPARTMENT OF ECONOMICS

EDMONTON, ALBERTA

JANUARY 29, 1968

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled AN ECONOMIC CRITIQUE OF THE COLUMBIA RIVER TREATY AND PROTOCOL submitted by Richard H. M. Plain in partial fulfillment of the requirements for the degree of Master of Arts.

ABSTRACT

The agreement between Canada and the United States for a multi-purpose development of the Columbia River Basin established a number of economic and legal precedents for the utilization of water resources in an international river basin. The primary objective of the thesis is to evaluate the economic import of the agreements incorporated in the Columbia River Treaty and Protocol in terms of their ability to ensure the maximization of the benefits derived from a multi-purpose river development.

The basic conclusion of the thesis is that the economic format on which the Treaty and Protocol Agreements were formulated was incomplete and at best misleading. Particular emphasis is placed on the inadequate treatment of the problems of regional growth, technical advance and the efficient utilization of water resources in the Canadian portion of the Columbia River Basin.

ACKNOWLEDGEMENTS

I wish to thank Professor S. E. Drugge for the time he has spent with me discussing various portions of this thesis. The suggestions made with respect to the organization of the thesis have been extremely valuable.

My deepest thanks are extended to my wife who has displayed exceptional fortitude both during the stage when the thesis was being written and finally in carrying out the laborious tasks involved in typing the manuscript.

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CHAPTER I

INTRODUCTION

Water is far from a simple commodity,
Water's a sociological oddity,
Water's a pasture for science to forage in,
Water's a mark of our dubious origin,
Water's a link with a distant futurity,
Water's a symbol of ritual purity,
Water is politics, water's religion,
Water is just about anyones pigeon,
Water is frightening, water's endearing,
Water's a lot more than mere engineering,
Water is tragical, water is comical,
Water is far from the Pure Economical,
So studies of water, though free from aridity,
Are apt to produce a good deal of turbidity.

It is evident that Professor Boulding is not the American equivalent of Britain's poet laureate; however, in the course of one short verse he has managed to make a number of succinct and penetrating comments which aptly characterize the mix of social and scientific opinions emanating from a consideration of the problems involved in allocating water resources to various alternative ends. There will be no attempt made in this thesis to explain why problems in the field of water resource economics arouse emotive responses from almost all of the various vested

1
K. E. Boulding, "The Economist and the Engineer: Economic Dynamics of Water Resource Development", Economics and Public Policy in Water Resource Development, Edited by S. C. Smith and Smery N. Castle (Ames, Iowa: Iowa State University Press, 1965), p. 86.

interest groups in society. Boulding's verse serves as a useful description of the prevailing state of affairs.

The basic reason for undertaking a critical examination of the agreements incorporated in the Columbia River Treaty and Protocol is to refute or accept the contention that the economic analyses underlying major water resource studies in Canada are generally incomplete and do not serve as a useful guide for policy decisions. The Columbia River Treaty and Protocol was chosen for this type of an examination because it not only involves the conventional problems of attempting to evaluate the benefits and costs to society involved in constructing joint hydro-electric and flood control projects within a particular region, but also the problems involved in developing the water resources of an international basin in such a way that it is of a mutual benefit to each of the respective riparians. It is felt that given the current interest in multi-purpose river development in Canada--for example the Churchill Falls project in Labrador, the St. John River development proposals in New Brunswick and the Nelson River studies in Manitoba--a careful appraisal of the economic analyses carried out on the Columbia Basin could reap substantial benefits in terms of suggesting methods of resolving problems common to all inter and intra regional water allocation projects.

It should be noted that the topics discussed in the thesis are only concerned with the economic aspects of the

allocation of water resources in the Columbia River Basin. The multitude of political, engineering and sociological factors are examined only in the sense that they have certain economic costs and benefits, not in terms of offering any explanation of their occurrence.

There are two basic economic tools of analysis which are employed in various portions of the thesis. It is assumed that both tools, cost-benefit analysis and regional growth analysis are common knowledge.

Historical Summary of the Main Events Leading to
the Commencement of Construction on the
Columbia River Treaty Projects
(1944 - 1964)

There are a number of events which have affected the course of development of the Columbia River Treaty and Protocol agreements. It is essential for a clear understanding of the economic implications of the effect of basic changes in the Treaty agreements that the temporal sequence of these events should be carefully delineated.

The initial step in the investigation of the water resources of the Columbia River Basin originated in 1944 from a joint request submitted by Canada and the United States to the International Joint Commission:

It is desired that the Commission shall determine whether in its judgment further development of the water resources

1
Refer to A. R. Prest and R. Turvey, "Cost-Benefit Analysis: A Survey", Resource Allocation, Vol. III of Surveys of Economic Theory (New York: St. Martin's Press, 1967), pp. 155-207 and H. S. Perloff et. al, Regions, Resources and Economic Growth (Lincoln, Nebraska: University of Nebraska Press, 1960), pp. 55 - 106.

of the river basin would be practicable and in the public interest from the points of view of the two governments, having in mind (A) domestic water supply and sanitation, (B) navigation, (C) efficient development of water power, (D) the control of floods, (E) the needs of irrigation, (F) reclamation of wet lands, (G) conservation of fish and wildlife, and (H) other beneficial public purpose.¹

This request led to the formulation of the International Columbia River Engineering Board to undertake the necessary research studies.

Fifteen years elapsed between the commencement of the International Columbia River Engineering Board studies of the Columbia River basin and the tendering of their final report to the International Joint Commission on March 1, 1959. During this fifteen year period a number of surveys of portions of the Columbia basin were undertaken by the American Army Corps of Engineers; their report on the American portion of the basin was submitted in 1949. The main international consequence of the Army Corps studies was an American proposal to the International Joint Commission for permission to construct a dam on the Kootenay River at Libby, Montana to provide hydro-electric and flood control benefits in the American portion of the basin. This proposal coupled with American worries over providing sufficient reservoir storage to meet future power demands led to a request in 1959 by both Canada and United States to the International Joint Commission asking for the issuance of the International Columbia River

¹ International Columbia River Engineering Board, Water Resources of the Columbia River Basin (Abstract), a Report to the International Joint Commission - United States and Canada (Washington: The Board, 1959), p. 1.

Engineering Board report on the Columbia River Basin. After receiving the report both governments requested an additional study by the International Joint Commission to see if a basis could be found for sharing the benefits and costs resulting from the construction of inter-related, multi-purpose storage reservoirs. During the period between the issuance of this report (International Joint Commission report on "Principles for Determining and Apportioning Benefits from Cooperative Use of Storage Waters and Electrical Interconnection within the Columbia River System", submitted December 29, 1959) a number of meetings were held between the governments of Canada and British Columbia in an attempt to formulate a common approach to be used in the forthcoming negotiations with the United States.

The first of a series of meetings between Canadian and American negotiators started on February 11, 1960. On the basis of agreements achieved in the subsequent discussions the representatives of each country signed the Columbia River Treaty on January 17, 1961 at Washington, D. C. The American Senate ratified the Treaty within a few months after signing; however, ratification by Canada did not occur because a difference of opinion arose between Canada and British Columbia over the definition of each government's respective responsibilities and British Columbia's desire to change or amend certain of the Treaty agreements. In essence the sale of the Canadian share of the American increase in hydro-

electricity resulting from Canadian storage and the Government of Canada's ban on the export of hydro-electric power were the two basic points of contention. The impasse between the two governments remained until 1963 when Prime Minister Pearson and President Kennedy agreed to undertake negotiations on a Protocol to the Treaty which would embody certain clarifications and adjustments to the original Treaty agreements. After this action by the Federal Government the governments of Canada and British Columbia signed an agreement on July 8, 1963 (British Columbia-Canada Agreement) which delineated the roles and areas of responsibilities of each respective government. Negotiations on the Protocol between Canada and the United States commenced on August 1, 1963. On January 22, 1964 the exchange of notes containing the amendments to the Treaty were signed between Canada and the United States and on March 3, 1964 the Columbia River Treaty and Protocol agreements were referred to the Standing Committee on External Affairs. In September 1964, after two decades of study and negotiations the ratifications of the Treaty and Protocol were exchanged between Canada and the United States.

CHAPTER II

BACKGROUND TO THE COLUMBIA RIVER TREATY OF 1961

Topography of the River and Its Basin

The Columbia River has one of the largest volumes of flow of any river in North America. Its mean annual discharge of 250,000 cubic feet per second is exceeded only by the Mississippi, MacKenzie and St. Lawrence rivers. The Columbia basin has a maximum width of 750 miles and extends approximately 270 miles north into Canada and 550 miles south into the United States.¹ The Canadian portion of the basin (39,500 square miles) is located in southeastern British Columbia while the American portion (219,500 square miles) encompasses the major portions of the states of Idaho, Oregon, Washington and Montana (west of the Continental Divide) and relatively small areas of Nevada, Utah and Wyoming. (Refer to Figure 1.)

The source of the Columbia River is Columbia Lake, situated in the Rocky Mountain Trench at an altitude of approximately 2,654 feet. The Columbia River flows in a northwesterly direction from Columbia Lake around the northern extensions of the Purcell and Selkirk mountains, at which

¹Figure 1 provides orientation for the discussion surrounding the topographical characteristics of the Columbia Basin.

point it makes a sharp turn (The Big Bend) and flows in a

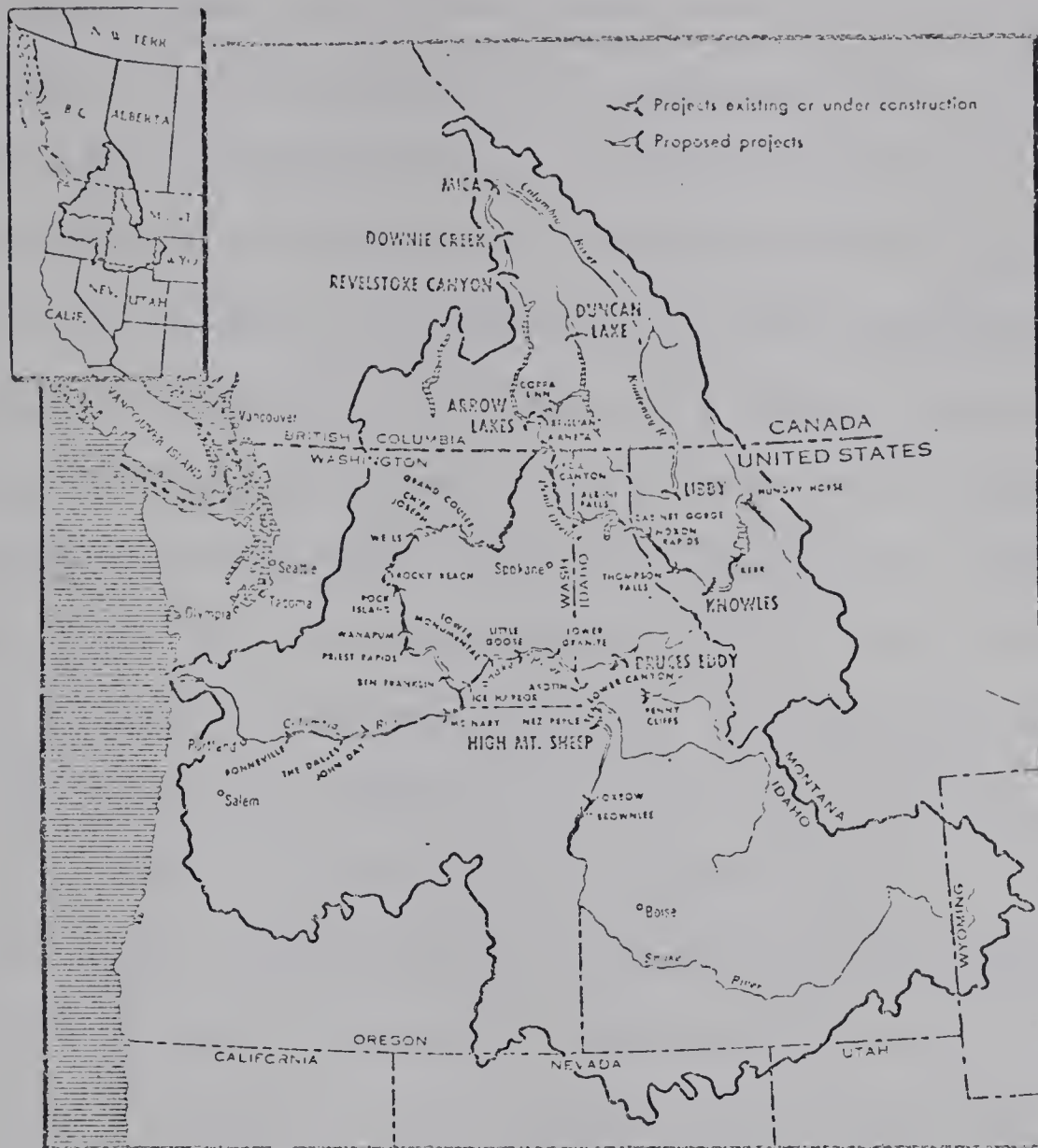


FIGURE 1.--Developments in Columbia River system existing or under construction in 1960, and those proposed during Treaty negotiations.¹

southerly direction down the Selkirk Trench to its confluences with the Kootenay and the Pend d'Oreille rivers. The total distance traversed by the Columbia River in Canada is approximately 480 miles while the total decrease in altitude from its source to the international border amounts to 1,366 feet. The flow on the mainstem of the Columbia River at the inter-

¹ J. V. Krutilla, The Columbia River Treaty (Baltimore, Maryland: John Hopkins Press, 1967), p. 24.

national border is equal to 40% of the river's ultimate discharge. Seventeen per cent of this flow is from the Columbia proper, 12% is contributed by the Kootenay River while the remaining 11% is accredited to the Pend d'Oreille River.

In the United States the Columbia River flows southward until it reaches its confluence with the Spokane River; at this point it changes direction and flows westward until it is joined by the Okanogan River. From this juncture the river flows in a southerly direction until it is joined by the Snake River and flows westward into the Pacific Ocean. The total distance from the source of the Columbia River to the Pacific Ocean is 1,225 miles, while the total over-all fall of the river is approximately 2,654 feet.

During the negotiations surrounding the Columbia River Treaty and the ensuing Protocol the Kootenay River served as a main point of focus in the various hydro and flood control projects suggested by both Canada and the United States. It is useful to carefully trace the circuitous path described by this river as it flows through both countries. The source of the Kootenay River is located in the Rocky Mountains south-east of Golden, British Columbia at an altitude of 4,150 feet. (Refer to Figure 1.) The river parallels the Columbia River for a distance of eighty miles before it turns in a westerly direction and enters the Rocky Mountain Trench. At Canal Flats the Kootenay River passes within a mile of Columbia Lake before continuing in a southerly direction across the

international border. Its southward progression into the United States ends near Libby, Montana where it swings northward along the Purcell Trench and enters Canada approximately forty-seven miles downstream from Bonners Ferry, Idaho. It flows another twenty-eight miles in Canada until it reaches Kootenay Lake and is joined by the discharge from the Duncan River flowing southward into the north end of the lake. From the outlet of the lake, the Kootenay River flows in a westerly direction to join the Columbia River near Castlegar some twenty-nine miles from the border.¹

Climatic and Flow Conditions of the Basin

The climatic conditions of the Columbia River Basin tend to provide a maximum river flow during the late spring and early summer months and a minimum flow during the winter months of January and February. The main meteorological factors responsible for this hydrological variability on the mainstream of the Columbia River result from a combination of continental and maritime influences. The maritime conditions prevail west of the Cascade range, while on the east side continental weather patterns prevail during the summer. Reference to Figure 2 indicates the extreme variability of the levels of precipitation in various sections of the basin. As an example, it has been noted that an annual precipitation of 150 inches has been recorded along the summits of the Coastal

¹ Approximately thirteen miles below this point the Pend d'Oreille River joins the mainstream of the Columbia River.

Range while at the same time certain areas of central Washington have recorded a precipitation level of only seven inches.

On the west side of the Cascades the majority of the precipitation occurs in the form of rain, usually during the winter months. As a result there is generally a one to one

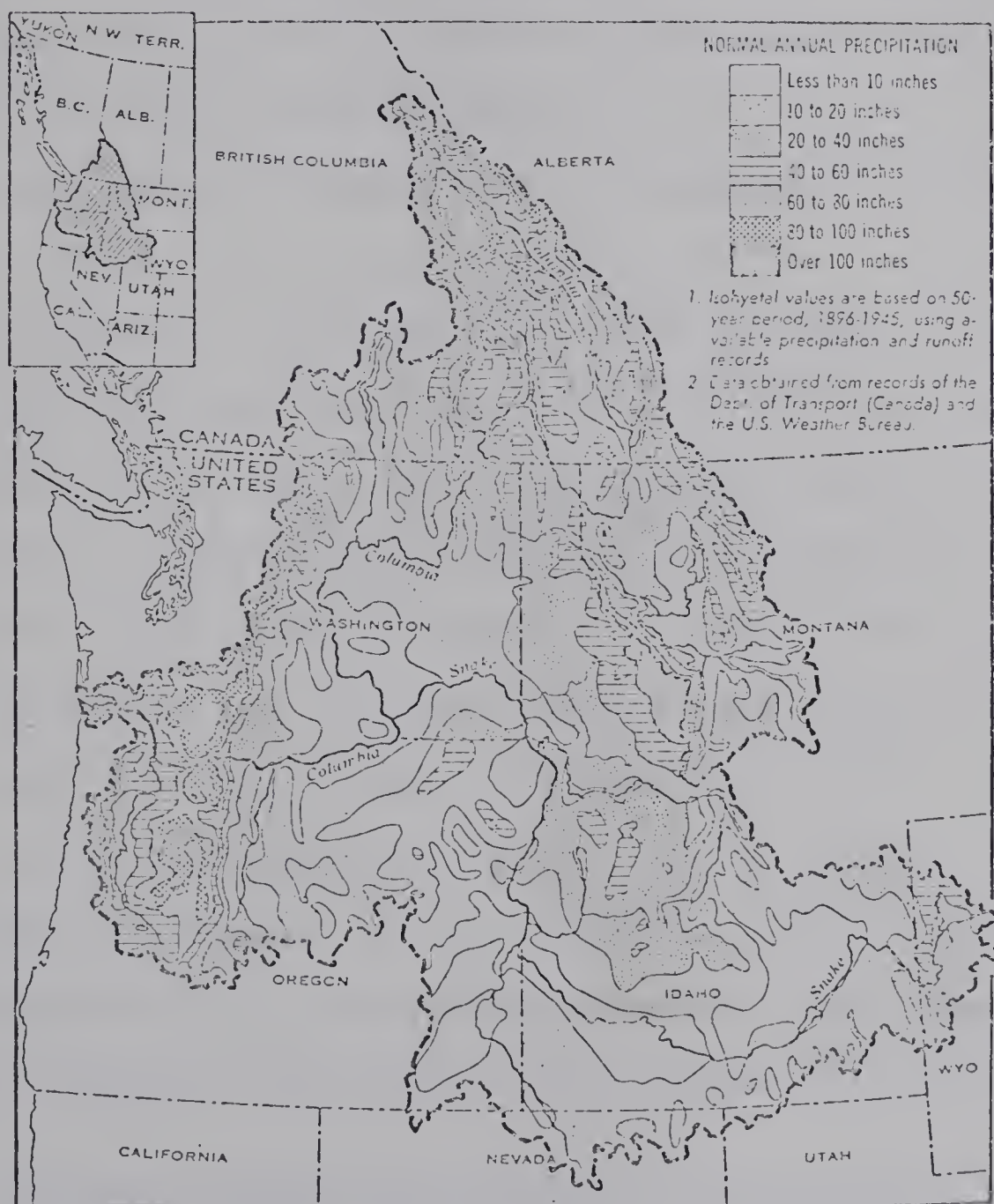


FIGURE 2.--Climatic characteristics of the Columbia River Basin.

correspondence between the period of peak precipitation and

peak runoff. On the east side of the Cascades and the western slopes of the Rockies the precipitation occurs mostly in the form of snow which accumulates in packs until the spring thaw. The rate of release of the moisture trapped in the snow packs is governed by the temperatures experienced during the spring and summer months. Warm spring rains and high temperatures often combine to produce severe floods in the plains of the lower Columbia.

The largest known flood on record occurred during June of 1894. The maximum discharge at The Dalles, Oregon was estimated at 1,240,000 cubic feet per second while the peak stage was 26.6 feet above the stage at mean annual flow. The extremity of variation of mainstream flow on the Columbia River at the international boundary has ranged from 680,000 to 12,900 cubic feet per second. At Revelstoke (on the upper Columbia) the highest recorded flow exceeds the lowest by a factor of ninety-nine. By contrast the St. Lawrence River flows range from two to one. On the basis of the preceeding discussion it is a sine qua non for optimal hydro-electric and flood control operations on the Columbia to provide adequate regulation of the stream flow variation.

The Pre-treaty Development of the Columbia Basin

Flood Control and Hyrdo-electric Development on the American Portion of the Columbia River

Prior to the signing of the Columbia River Treaty in

1961 a substantial amount of multi-purpose river development (primarily for flood control and hydro-electric purposes) had been carried out in the United States.¹ In its 1959 report the International Joint Commission noted that:

The area of major flood damage in the Columbia Basin lies along the 140 mile reach of the mainstem below Bonneville Dam. The flood plain consists of a series of low, flat areas generally three to four miles wide and five to ten miles long, separated by sloughs or minor tributaries entering the main channel. Because of high agricultural values as well as high-value urban or industrial development approximately sixty per cent of this flood plain has been protected in some degree by levees and other protective works.²

Flood levels experienced during 1956 demonstrated that these works were sufficient to contain floods up to 800,000 cubic feet per second as measured at The Dalles. These facilities coupled with the existing 10.5 million acre-feet of potential storage available upstream leave the flood plain subject to approximately 21% of the total potential damage.

One general comment suffices to describe the hydro-electric development on the American portion of the Columbia River as of 1960. The American hydro-electric development of the Columbia River basin neglected to provide sufficient storage reservoirs and as a result the hydro authorities

¹At this time the British Columbia portion of the Columbia mainstem did not have installations on it. Limited development had taken place on the lower Kootenay. (Refer to Figure 1 and Table 1 for relevant locational, head, storage and capacity information.)

²International Columbia River Engineering Board, "Mainstem Columbia River and Minor International Tributaries in the United States", Water Resources of the Columbia River Basin, Appendix V, a Report to the International Joint Commission - United States and Canada (Washington: The Board, 1959).

were unable to operate their existing installations within any type of an optimal power generation framework. Examination of Table I indicates the majority of the installations are 'run-of-the-river' plants. On the mainstem there is approximately 9.7 million kilowatts of installed capacity with storage facilities of only approximately 6.1 million acre-feet. The importance of the relationship between power and storage is easily demonstrated by referring to an example provided by J. V. Krutilla.¹ Krutilla maintains that without regulation the Columbia River system in 1959 could only produce 2,972 megawatts of 'prime power'. Utilization of the storage for stream regulation provides 5,310 megawatts or an 80% increase in output. Without any further development of head an additional 5.5 million acre-feet of storage upstream from Grand Coulee Dam would provide an increase of prime power of 1000 megawatts.²

¹Ibid., p. 23.

²The term 'prime power' is used in a special sense. Power is sold to a consumer on the basis that the power will be available at the convenience of the consumer. This is reflected in peak demands on a system. The ability of a system to meet its peak demands is referred to as the firm load-carrying capability or the 'dependable capacity' of the system. Thermal and hydro-electric systems differ in that the installed capacity of a hydro system does not necessarily represent the dependable capacity of the system. The production of hydro-electric power is directly related to the flow of water over a given head. The dependable capacity of the system is subject to a constraint determined by the amount of water available during the most adverse stream flow conditions. It is obvious that storage which regulates stream flow has an important bearing on the dependable capacity of the system since a basic characteristic of electric power is that it cannot be stored or accumulated for future dispensation.

TABLE I.--Major power projects on the Columbia and major Tributaries east of Cascades, 1959 ¹

Projects	Gross Head (feet)	Installed capacity (kilowatts)	Storage (acre-feet)
Kootenay River			
Corra Linn	53	40,500	817,000
Upper Bonnington	70	54,700	Pondage
Lower Bonnington	70	47,250	Pondage
South Slocan	70	47,250	Pondage
Brilliant	93	81,600	Pondage
Clark Fork-Pend Oreille			
Hungry Horse	477	285,000	2,980,000
Kerr	187	168,000	1,219,000
Thompson Falls	47-60	30,000	Pondage
Noxon Rapids	154	336,000	Pondage
Cabinet Gorge	97	200,000	Pondage
Albeni Falls	28	42,600	1,155,000
Box Canyon	28-42	60,000	Pondage
Waneta	210	144,000	Pondage
Snake River and Tributaries			
Palisades	245	114,000	1,202,000
American Falls	48	27,000	--
Upper Salmon	45	34,500	Pondage
Lower Salmon	59	60,000	Pondage
Anderson Ranch	326	27,000	423,200
Brownlee	272	360,400	1,000,034
Oxbow	122	190,000	Pondage
Little Goose	100	405,000	Pondage
Lower Monumental	100	405,000	Pondage
Ice Harbor	100	270,000	Pondage
Columbia River (Mainstem)			
Grand Coulee	341	1,944,999	5,072,000
Chief Joseph	171	1,024,000	Pondage
Wells	68	490,000	Pondage
Rocky Reach	95	712,000	Pondage
Rock Island	49	206,400	Pondage
Wanapum	80	831,000	500,000
Priest Rapids	80	788,000	170,000
McNary	78	980,000	Pondage
John Day	104	1,200,000	500,000
The Dalles	86	1,119,000	Pondage
Bonneville	59	518,400	Pondage

¹Krutilla, op. cit., p. 25.

In its 1959 report the International Columbia River Engineering Board noted that while only 13.3 million acre-feet of storage capacity was available for use by power plants on the mainstem of the Columbia River there existed potential resevoir sites in the American portion of the basin which could increase the storage capacity to approximately 50 million acre-feet. This seems to greatly understate the problems involved in obtaining large tracts of land for resevoir storage in the Pacific Northwest, given the political influence of conservationists and landowning groups in that area. In a more realistic appraisal of the situation the 'Board' pointed out the existence of a number of favourable sites in British Columbia which could provide the storage required for an optimal utilization of water in the basin with only a minor degree of conflict to vested interests.

The prime power capability of a system refers to the average generation capability of a system over the 'critical period'. The critical period refers to that period of time between the beginning of drafting from full resevoir elevations to the completion of the refilling operation. In effect, since electric energy cannot be stored the potential energy of water is stored by returning the water to the resevoirs for release at times when the rate of utilization through the turbines exceeds stream flow into the resevoir.

In the case where power is generated when the cumulative inflow to the resevoirs exceeds storage capacity and firm load requirements the 'excess' energy is referred to as secondary or interrupted power and sold on an 'if and as available' basis provided a market is available. It is evident that the existence of large amounts of secondary energy in a system has important repercussions on the value of additional storage added to the system.

International Columbia River Engineering Board,
Abstract, loc. cit.

Developments in the Canadian Portion of the Columbia Basin

An examination of Figure 1 shows that relatively few hydro-electric sites were developed in the Canadian portion of the Columbia basin. In fact prior to 1961 there was no development on the mainstem of the Columbia and only 364 feet of head developed on the lower Kootenay between Kootenay Lake and the mouth of the Kootenay River. The development at the Brilliant site (along with outlet improvements on the Kootenay Lake) provided 800,000 acre-feet of controlled storage and a maximum potential hydro-electric output of 271,000 kilowatts.

It is evident from a comparison of the American and Canadian developments that the United States entered the Columbia negotiations with the intent of obtaining storage reservoirs in British Columbia for the purpose of providing flood control and increased hydro-electric generation on the lower Columbia River. Since Canadian development of the Columbia River system was relatively negligible, Canadian negotiators were in a position where they could examine the widest range of alternative developments without facing the constraint of attempting to optimize the use of existing capital commitments.

CHAPTER III

THE BASIC ECONOMIC FORMAT OF THE COLUMBIA RIVER TREATY

Two major reports of the International Joint Commission, presented in March and December 1959, served as the basic economic format on which the Canadian and American Treaty proposals were predicated.¹ The main purpose of this chapter is to briefly set out the main tenets of both reports. The economic implications of the International Columbia River Engineering Board plans of development and the various principles contained in each report will be examined in Chapter IV.

The International Columbia River Engineering Board Report

The March 1959 report of the International Columbia River Engineering Board to the International Joint Commission identified three possible alternative plans of development which they stated would produce potential benefits that

¹ International Columbia River Engineering Board, Water Resources of the Columbia River Basin, Abstract and Appendices I to VI, submitted to the International Joint Commission - United States and Canada (Washington: The Board, March 1959), and "Principles for Determining and Apportioning Benefits from Cooperative Use of Storage of Waters and Electrical Interconnection Within the Columbia River System", a Report by the International Joint Commission, The Columbia River Treaty Protocol and Related Documents, Issued by the

would be nearly equal in terms of their total effect on the Columbia River Basin.

The Non-Diversion Plan

The Non-Diversion Plan¹ does not interfere with the



FIGURE 3.--Non-Diversion Plan.

natural channels of the respective rivers. Storage for flow regulation would be established at Arrow Lakes and Mica on the Columbia River and at one of two alternative sites on

Department of External Affairs and Northern Affairs and National Resources (Ottawa: Queen's Printer, February 1964), pp. 39 - 55.

¹ Note this plan is referred to as sequence VII in the International Columbia River Engineering Board report.

the upper Kootenay, Dorr-Bull River on the Canadian side of the border or Libby, Montana on the United States side. Either one of the two alternative sites would regulate flows on the lower Kootenay and Columbia rivers.

The Dorr Creek Diversion Plan

The Copper Creek and Dorr Diversion Plans¹ are alternatives which exclude the Non-Diversion Plan. The Dorr Creek



FIGURE 4.--Dorr Creek Diversion Plan.

¹ In the International Columbia River Engineering Board report the Dorr Diversion Plan is referred to as sequence IX. General McNaughton (at one time a Canadian representative on the International Joint Commission) strongly championed a variation of the above scheme. His plan has often been called the McNaughton Plan of development or scheme IXA. The sole difference between sequence IX and IXA lies in the height of the High Arrow Dam. McNaughton favored a lower structure because of the rather extensive flooding which would occur in

Diversion Plan is based on a diversion of the Kootenay River into the Columbia River near Canal Flats. Approximately 8,000 cubic feet per second of the 11,000 cubic feet per second flow of the Kootenay River would be diverted by providing storage facilities at the Luxor, Bull River and Dorr sites. Pumping facilities would be necessary to lift water from the Dorr into the Bull River-Luxor reservoir in order to direct the flow of the Elk River tributary of the Kootenay River into the Columbia River. A storage project on the Duncan River would be provided to aid in the regulation of stream flow to the 'run-of-the-river' plants in the lower Kootenay River.

The Copper Creek Diversion Plan

The Copper Creek Diversion Plan¹ consists of a more limited diversion of the Kootenay River flow into the Columbia River. (3,600 vis-à-vis 8,000 cubic feet per second.) The plan is essentially identical with the Dorr Plan with the exception that the small diversion does not exclude the Libby, Kootenai Falls (American spelling) and Katka sites in the United States.

the Arrow Lakes region if the projects set out in sequence IX were fully implemented. Refer to: Canada, Standing Committee on External Affairs, Minutes of Proceedings and Evidence, Columbia River Treaty and Protocol, Number 9, 26th Parliament 2nd session (Ottawa: Queen's Printer, 1964), p. 518

¹ Note this plan is referred to as sequence VIII in the International Columbia River Engineering Board report.



FIGURE 5.--Copper Creek Diversion Plan

An examination of each of these three plans indicates that the Diversion vis-à-vis the Non-Diversion Plans would result in a shift in power production from the United States to the Canadian side of the border. The Dorr Diversion Plan would insure the greatest total increase in power in Canada and the least in the United States. The situation is exactly reversed in the Non-Diversion case.

The International Joint Commission Criteria for
System Selection and the Apportionment of
Benefits

After receiving the analysis included in the International Columbia River Engineering Board report of January 1959, Canadian and American negotiators were faced with the

problems of establishing criteria on which the benefits arising from a joint hydro-electric and flood control scheme should be divided between each country. Their problem was to determine which plan of development should be adopted and to what extent the sequence of completion of each particular project would affect the benefits assigned to that project. The question of establishing criteria for resolving these problems was given to the International Joint Commission. After eleven months of deliberation the International Joint Commission prepared a report establishing three sets of principles: three general principles, seven power principles and six flood control principles for benefit determination and apportionment in the Columbia River System.¹ It is not possible to examine each of the principles in detail; therefore, only the ones judged to be of prime importance in the negotiation will be considered.

General Principle No. 1

Each of the principles contained in the report is accompanied by a discussion interpreting various aspects of each principle. General Principle No. 1 states:

Cooperative development of the water resources of the Columbia River Basin, to each country, requires that the storage facilities proposed by the respective countries will, to the extent it is practicable and feasible to do so, be carried out in the order of the most favourable benefit-cost ratio with due consideration of factors not

¹"Principles for Determining and Apportioning Benefits from Cooperative Use of Storage of Waters and Electrical Interconnection Within the Columbia River System", loc. cit.

reflected in the ratio.¹ (*italics mine*)

In the discussion it is noted that:

The phrase "to the extent that it is practical and feasible to do so" is included in recognition of the fact that it will not always be possible to adopt a project wholly on the basis of its benefit-cost ratio as compared to other projects in the river basin. There may be important non-monetary factors, not reflected in the benefit-cost ratio, which may require consideration and which may be of compelling influence in choosing projects for construction. Such factors include the disruption of community and regional economies, scenic, historic or aesthetic considerations, the preservation of fish and wildlife and similar considerations which cannot be adequately evaluated in monetary terms.²

The discussion goes on to mention that the availability of funds, the urgency of local requirements in the fields of flood control and hydro-electric requirements and the attitudes of certain interests with respect to the flooding of property may lead to the abandonment or selection of projects other than on the basis of benefit-cost ratios.

One additional comment on General Principle No. 1 should be noted:

If projects are developed successively to meet the growing needs for power production and to provide flood protection, the most efficient projects for those purposes should generally be developed first in order to maximize the net benefits to each country.³ (*italics mine*)

General Principle No. 1 was primarily established to give guidance in selecting the most economically viable plan of development and order of project completion. Given the assumption that this objective has been achieved, guidance

¹ Ibid., p. 41

² Ibid., pp. 40-41.

³ Ibid., p. 41.

is required in measuring and dividing the resulting benefits. The main International Joint Commission criteria for achieving this end are set out in General Principle No. 2, Power Principle No. 6 and Flood Control Principles No. 3 and 4.

General Principle No. 2

General Principle No. 2 states:

Cooperative development of the water resources of the Columbia River basin should result in advantages in power supply, flood control or other benefits, or savings in costs to each country as compared with alternatives available to that country.¹ (*italics mine*)

This statement points out that despite the multi-purpose nature of the Columbia River projects and the trade-offs occurring in certain areas the effect of entering a cooperative development scheme must be such that each country could secure greater net benefits than under any individual undertaking.

Power Principle No. 6

The following criteria set forth the International Joint Commission's appraisal of how this goal can be achieved in the fields of flood control and hydro-electric generation. Power Principle No. 6 establishes the procedure to be followed in dividing benefits accruing from the increased generation of hydro-electric power.

The power benefits determined to result in the downstream country from regulation of flow by storage in the upstream country should be shared on a basis such that the benefit, in power, to each country will be substantially equal provided that such sharing would result in an advantage to each country as compared with alternatives available to that country, as contemplated in General Principle No. 2. Each country should assume responsibility for

¹Ibid., p. 42

providing that part of the facilities needed for the cooperative development that is located within its own territory. Where such sharing would not result in an advantage to each country as contemplated in General Principle No. 2, there should be negotiated and agreed upon such other division of benefits or other adjustments as would be equitable to both countries and would make the cooperative development feasible.¹ (*italics mine*)

Flood Control Principles No. 3 and 4

The procedures for the division of flood control benefits are set out by: (a) Flood Control Principle No. 3- "The monetary value of the flood control benefit to be assigned to the upstream storage should be the estimated average annual value of the flood damage prevented by such storage."²

(b) Flood Control Principle No. 4 - "The upstream country should be paid one-half of the benefits as measured in Flood Control Principle No. 3, that is, one-half of the value of damages prevented."³

General Principle No. 3

General Principle No. 3 states:

With respect to trans-boundary projects in the Columbia basin, which are subject to the provisions of Article IV of the Boundary Water Treaties of 1909, the entitlement of each country to participate in the development and to share in the downstream benefits resulting from storage and in power generation at site, should be determined by crediting to each country such portions of the storage capacity and head potential of the project as may be mutually agreed.⁴ (*italics mine*)

¹ Ibid., p. 50

² Ibid., pp. 53-54.

³ Ibid., pp. 53-54.

⁴ Ibid., p. 43. It is evident that the phrase "as may be mutually agreed" is designed to serve as a key for continuing negotiations when everything else has failed but the application of standard bargaining procedures.

CHAPTER IV

A CRITIQUE OF THE ECONOMIC FORMAT AND THE MODE OF ANALYSIS USED IN ESTABLISHING THE AGREEMENTS INCORPORATED IN THE COLUMBIA RIVER TREATY

There are three distinct though inter-related bodies of criticism contained in the following discussion. Parts one and two deal with an evaluation of the relative economic merits of the two reports released through the auspices of the International Joint Commission. Part three is concerned with an economic evaluation of the actual Treaty agreements.

Criticism of the International Columbia River Engineering Board Report

The first and major point of criticism of the International Columbia River Engineering Board Report is that the report did not fulfill its terms of reference. It is suggested that the failure of the report to achieve this end is one of the basic reasons why the economic objectives of both Canada and the United States with respect to a mutual development and an optimal allocation of water resources in the Columbia basin were never achieved. In fact, if the terms of reference given to the International Columbia River Engineering Board had been filled by the Board there may

never have been any attempt to formulate a treaty. Support for this conclusion can be found by comparing the International Joint Commission's interpretation of their own report with paragraph three of the terms of reference given to the International Joint Commission.

The submission of the Report in March 1959 completed the preliminary stage of the Columbia River investigation. The Report is an engineering appraisal of the possibilities of full cooperative development; it is not in any sense a proposal or specific recommendation. . . . Investigations supporting the Report are comprehensive in nature. Cost estimates in most cases are preliminary, but they are adequate for comparative project or system justification. In accordance with instructions from the International Joint Commission, no attempt is made to apportion costs and benefits or indemnification for damages for specific projects between the two countries. However, facts and conclusions are presented which may serve as a basis for recommendations to the two countries.¹

A comparison of this statement with paragraph three of the terms of reference given to the International Joint Commission by the United States and Canadian governments indicates that the International Joint Commission and the International Columbia River Engineering Board report completely failed to fulfill the main purpose for which the report was carried out:

In the event that the Commission should find that further works or projects would be feasible and desirable for one or more of the purposes indicated above, it should indicate how the interests on either side of the boundary would be benefited or adversely affected thereby, and should estimate the costs of such works or projects and the costs of any remedial works that may be found to be necessary and should indicate how the costs of any projects and the amounts of any resulting damage be

¹ International Columbia River Engineering Board, Abstract, op. cit., p. 1.

apportioned between the two Governments.¹

One comment in addition to the self-evident discrepancies between the foregoing two statements should be made. The phrase "Cost estimates in most cases are preliminary, but they are adequate" is a normative term (value judgment) rather than a positive phrase. This is obvious because:

- (a) if the cost figure is preliminary it implies there may exist a significantly different set of figures which have a greater or lesser quantitative effect;
- (b) if solely engineering (excluding social) costs and benefits are taken into account there is no guarantee that the term costs or benefits has any useful economic meaning (more will be said on this in the following discussion);
- (c) no criteria or standard of comparison is available on which the term 'adequate' can be delineated.

The paragraph dealing with the terms of reference requests that the International Joint Commission "... should indicate how the interest on either side of the boundary would be benefited or adversely affected. . ." It is suggested that since the International Joint Commission did not indicate how the relative benefits and costs were to be apportioned between the countries--a request for principles to guide the negotiators was sent to the International Joint Commission in January 1959--that the International Joint Commission did not and could not actually determine how the

¹ Ibid.

relative countries would be affected by the agreement. The tasks fulfilled by the International Columbia River Engineering Board were basically engineering tasks. The terms of reference asked for economic analysis of the engineering proposals. The lack of economic appraisal of the effects of the proposed plans of development did not provide the requisite guidelines required by the negotiators in attempting to evaluate the economic impact of the multitude of alternative plans on the Columbia basin as a whole and each country in particular.

The failure to provide analysis of this nature is reflected in the veritable flood of supplementary studies undertaken by various agencies and governments. The regional flavour of these studies tended to arm negotiators with studies designed to maximize benefits to a particular country or region rather than to the Columbia basin as a whole. The terms of reference were designed to bring the two countries to the negotiation table if a mutual development of the Columbia River system was beneficial to both. The lack of a comparative regional economic analysis by the International Columbia River Engineering Board did not enable either the Board or the participants to determine if the mutual approach was the most desirable.

Two additional areas of criticism result from an examination of the three major plans of development set out in the International Columbia River Engineering Board report.

First, the Board did not indicate the sequence in which various projects should be developed within each of the three basic plans. It is obvious that if projects are being developed on each side of the border and if each project had substantial storage that the accreditation of flood control benefits will vary on the basis of the first and last added storage. Also it is necessary that development should occur in such a manner that the maximum amount of hydro-electricity is derived from both the existing facilities as well as the newly added projects. Second, the basic development plans presented by the Board were selected on the basis of maximizing the hydro-electric output of the entire Columbia River system. It was assumed that achieving this goal would not interfere with an optimal utilization of water resources for other purposes such as irrigation, navigation, recreation, etc.¹ This immediately minimizes the usefulness of cost-benefit analysis by excluding certain relevant benefit considerations. It is suggested that on the basis of the foregoing criticisms the International Columbia River Engineering Board report must be judged as being totally inadequate in a number of key areas which were of paramount importance in aiding the decision making processes of the treaty negotiators.

Despite the inadequacies of the economic analysis

¹The International Columbia River Engineering Board statement in this respect is set forth in the 'Abstract', ibid., pp. 7-3.

carried out by the International Columbia River Engineering Board and the International Joint Commission, certain tentative conclusions can be drawn from their engineering findings. An examination of the three plans indicates that the Dorr Diversion plan is the least costly scheme for developing the hydro-electric potential of the Columbia River basin. Table 2 shows that the Dorr Diversion plan vis-à-vis the Non-Diversion plan results in a net gain of thirty-two megawatts of power and twenty megawatts of energy accompanied by a net difference in investment of \$366,705,000. The Dorr Diversion as compared to the Copper Creek Diversion plan yields a net power gain of -70 megawatts and a net energy gain of -110 megawatts. The important point is that the Dorr plan requires \$386,448,000 less investment. The substantial differences in total investment costs between the Dorr, the Non-Diversion and the Copper Creek Diversion plans chiefly result from the relatively expensive Libby, Kootenai Falls and Katka sites (expensive in relation to the output of hydro-electric power). It is evident that on the basis of the above examination the Dorr Diversion plan offers the best alternative for maximizing the hydro-electric potential of the entire Columbia system.¹

Criticism of the International Joint Commission
Report on Principles for Dividing
Benefits and Costs

Examination of the interpretation and the statement

¹ Note sequence IXa (McNaughton Plan) would take precedence over sequences VII and VIII.

TABLE 2.--Comparative data on range of Upper Kootenay
Diversion Alternatives¹

Project	Sequence VII Non- Diversion	Sequence VIII Copper Creek	Sequence IX Dorr with High Arrow	Sequence IXa Dorr Diversion with Low Arrow
Investment	(\$000)	(\$000)	(\$000)	(\$000)
Bull River (B.C.)	83,632	---	---	---
Dorr (B.C.)	---	---	35,840	35,840
Libby (U.S.)	342,800	312,800	---	---
Kootenai Falls (U.S.)	98,000	92,500	---	---
Katka (U.S.)	97,500	90,674	---	---
Duncan Lake (B.C.)	---	---	24,807	24,807
Kootenay River Plants (B.C.)	40,756	40,756	2,399	2,399
Bull River-Luxor (B.C.)	---	---	110,023	110,023
Copper Creek-Luxor (B.C.)	---	54,390	---	---
Calamity Curve (B.C.)	---	32,972	38,223	38,223
Mica Creek (B.C.)	302,442	314,805	327,167	327,167
Downie Creek (B.C.)	123,463	138,914	146,640	146,640
Revelstoke Canyon (B.C.)	104,379	116,904	123,168	123,168
Arrow Lakes (B.C.)	66,400	66,400	66,400	---
Murphy Creek (B.C.)	94,883	94,883	94,883	103,501
Total Investment	1,336,255	1,355,998	969,550	911,768
Total power				
Prime power (mw)	9,118	9,220	9,150	9,960
Average energy (mwh)	8,038	8,168	8,058	7,862
Canada:				
Investment (\$000)	615,955	860,024	969,550	911,768
Prime power (mw)	2,549	2,785	2,986	2,962
Average energy (mw)	2,441	2,682	2,352	2,852
United States:				
Investment (\$000)	520,300	495,974	---	---
Prime power (mw)	6,569	6,435	6,161	5,998
Average energy (mw)	5,597	5,486	5,206	5,010

¹ Krutilla, op. cit., p. 75

of General Principle No. 1 as set forth by the International Joint Commission indicates that there is evidence of confusion and mis-direction on the part of the International Joint Commission. Maximization of the net benefits to each country is not necessarily synonymous with a mutual sharing of benefits obtained by maximizing the net benefits for the entire system as a whole. It is possible to conceive of a situation whereby the maximization of benefits in country "A" may require construction of storage facilities in country "B" while the exact opposite situation holds for country "B". It is evident that a joint development will not lead to the conditions of net benefit maximization for the system and for each of the two countries.

Further examination of General Principle No. 1 indicates that while the Principle purports to provide a guideline for developing the optimum benefits from the Columbia River system it is actually self-contradictory when insistence is placed on projects being added on the basis of the most favourable benefit-cost ratio. Reference to Figure 6 indicates that at point one the ratio of benefits to costs is at a maximum while at point two marginal benefit equals marginal cost and net benefits are maximized. It is evident that selection of projects on the basis of their highest benefit-cost ratio does not coincide with the

¹Note sequence IXa (McNaughton Plan) would take precedence over sequences VII and VIII.

1 2
maximization of net benefits.

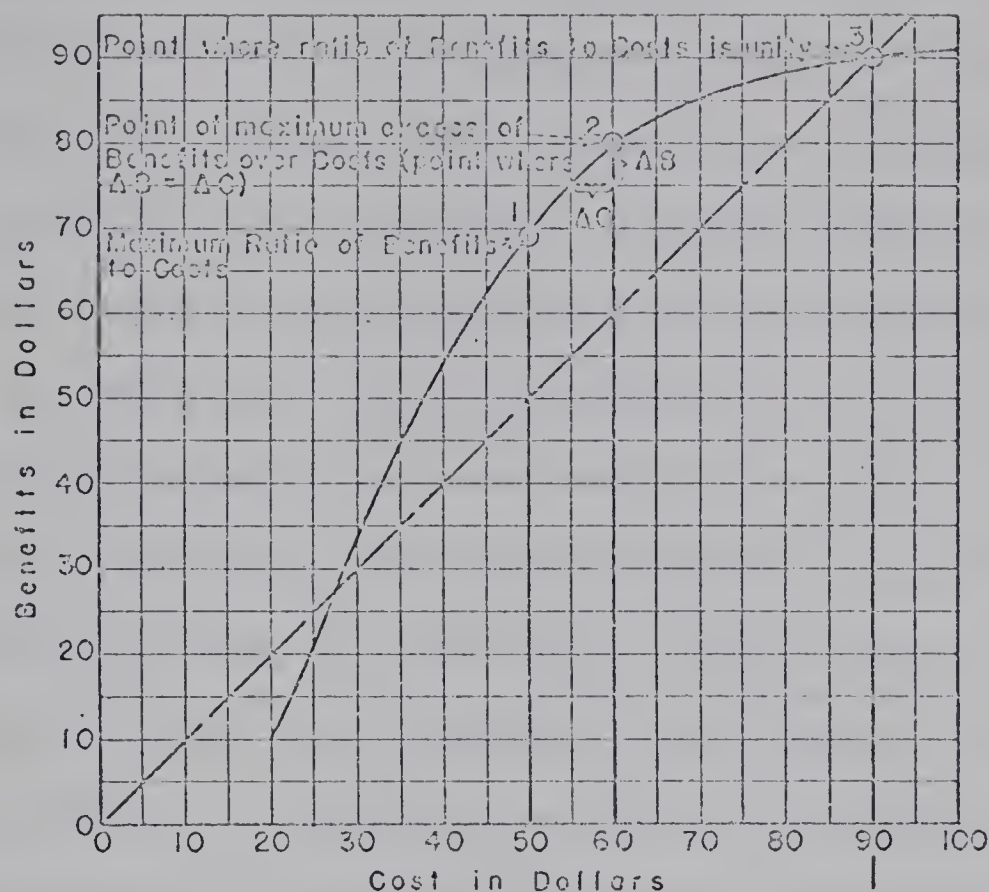


FIGURE 6.--Benefit cost relationships for various scales of development.

¹Proposed Practices for Economic Analysis for River Basin Projects, a Report to the Inter-Agency Committee on Water Resources for the Subcommittee on Evaluation Standards, Rev. Ed., Washington, D.C., 1958. Since Figure 6 is abstracted from the aforementioned Report--the standard hand book for water resource evaluation in the United States for the past two decades--one must seriously question the International Joint Commission's source of economic guidance.

²Krutilla, *op. cit.*, p. 63, provides a simple arithmetical example which clearly demonstrates this point. "A project with benefits having a present worth of \$150 million and present costs of \$75 million would have a more favourable benefit-cost ratio (2:1) than a mutually exclusive alternative with benefits having a present value of \$300 million and present costs of \$175 million (1.7:1). The increment in scale, comparing the two projects results in a greater addition to benefits than to costs, thus increasing the net benefit by \$50 million for the system in question."

One other major criticism of General Principle No. 1 and the discussion accompanying it must be made. Benefit-cost analysis cannot in its present state of development provide any final answers to the problem of determining the proper allocation of resources. Perhaps its best virtue is that it insures that projects which are highly unfeasible will not be adopted.¹ On these grounds the cautionary tones adopted in the discussion surrounding the blind adoption of benefit-cost ratios as the sole criteria in guiding the adoption of projects is justified. Unfortunately the International Joint Committee put forth these warnings after having submitted a report (International Columbia River Engineering Board) to the United States and Canadian governments which blatantly assumed that any benefits other than those accruing from hydro-electric and flood control were negligible. This must be considered as a classic case of 'bolting the door after the horse has fled'.

The normal and in fact absolutely necessary procedure which must be carried out in any benefit-cost analysis is to place a valuation on all the relevant costs and benefits. Certain cost and benefit items (so-called intangibles) must be listed even if they cannot be valued. If the total benefits minus the total costs derived from the tangible

¹Otto Eckstein, Public Finance, ("Foundation of Modern Economics Series"; Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), pp. 23-26.

valuation is a large positive figure and if the net benefits exceed those of alternative proposals, then a decision by policy makers to reject the project must rest on a weighting of intangible costs in excess of intangible benefits. If, because of political or other pressures, policy makers do not approve the project this process ensures that they are at least aware of the minimum weighting they place on their subjective evaluations.

It is evident that this approach to cost-benefit analysis was not employed by the International Joint Commission. As a result the International Joint Commission must be faulted for having formulated an economic guideline (General Principle No. 1) which can be used to justify certain projects which would be rejected on the basis of conventional economic analysis.

Examination of General Principles No. 1 and 2 and the Flood and Power Principles indicates that these principles may be wholly incompatible with each other. General Principle No. 1 has a goal of benefit maximization for each country. General Principle No. 2 has a goal of achieving greater benefits from the cooperative development of joint power and flood control projects than could be obtained in either home country. Power Principle No. 6 and Flood Control Principles No. 3 and 4 clearly state that benefits will be shared equally. It is evident that a sharing of benefits on a fifty-fifty basis cannot be considered as a

necessary and sufficient condition for the fulfillment of the objective of benefit maximization in either the sense of General Principle No. 1 or General Principle No. 2.

From a solely economic point of view it is difficult to understand the basis on which the foregoing International Joint Commission Principles were formulated. It would appear that the International Joint Commission criteria were stated in such a manner as to minimize the possibility of the respective negotiating teams reaching any conclusions based on a sound analytical framework.

An examination of General Principle No. 3 seems to indicate some possible rationale behind the logical confusion evidenced in the examination of the previous principles. This Principle basically implies that the apportionment and accreditation of benefits is open to negotiation. If this observation is correct then the conclusion is evident. The International Joint Commission was unable to provide a systematic economically valid body of criteria for guiding the negotiating teams. Instead, agreement was reached on formulating principles of a wide enough scope to include all possible projects that each of the negotiating countries could put forth in the hopes of improving their bargaining position.

One basic question remains unanswered, if the disagreements between the American and Canadian sections of the International Joint Commission could not be reconciled such

as to provide a coherent set of principles for the respective negotiating teams why was the International Joint Commission report on principles for dividing costs and benefits submitted to the respective governments? Achievement of a consensus to mutually agree on furnishing a set of contradictory mis-leading economic criteria can only insure failure in determining the optimal allocation of both nations scarce resources. It is suggested that formulating pseudo-economic principles designed to maintain the maximum latitude in bargaining will not provide the most desirable framework for achieving the purported goal of maximum economic efficiency. It is suggested that it is an entirely open question as to whether or not this type of action will even result in the establishment of criteria sufficient for obtaining the optimum in international bargaining positions.

A Critical Evaluation of the Major Columbia River Treaty Agreements

The above criticisms of the two reports of the International Joint Commission create a gloomy outlook as to the economic merits of the agreements incorporated in the 1961 Columbia River Treaty. Examination of the Treaty indicates that from a purely economic point of view these pessimistic portrends were more than amply realized.

The examination of the basic agreements incorporated in the Columbia River Treaty will be confined to the examination of the type of plan selected for the comprehensive

development of hydro-electric and flood control storage facilities on the Columbia and Kootenay Rivers. The terms under which the flood control and hydro-electric benefits were apportioned are basically those incorporated in Power Principles No. 6 and Flood Control Principles No. 3 and 4. It is felt that the previous criticism of these Principles will suffice for the Treaty Agreements. An examination of the Columbia River Treaty indicates that the format of the International Columbia River Engineering Board Non-Diversion Plan was adopted by the parties to the Treaty. This is set out in Article II of the Treaty.

(1) Canada shall provide in the Columbia River Basin in Canada 15,500,000 acre-feet of storage usable for improving the flow of the Columbia River.

(2) In order to provide this storage, which in the Treaty is referred to as the Canadian storage, Canada shall construct dams: (a) on the Columbia River near Mica Creek, British Columbia with approximately 7,000,000 acre-feet of storage; (b) near the outlet of Arrow Lakes, British Columbia, with approximately 7,100,000 acre-feet of storage; and (c) on one or more tributaries of the Kootenay River in British Columbia downstream from the Canadian-American boundary with storage equivalent in effect to approximately 1,400,000 acre-feet of storage near Duncan Lake, British Columbia.

(3) Canada shall commence construction of the Dams as soon as possible after the ratification date.

The development of the Libby project is proposed in Article XII--Kootenai River Development.

The United States of America for a period of five years

¹"Treaty Between Canada and the United States of America Relating to Cooperative Development of the Water Resources of the Columbia River Basin", The Columbia River Treaty Protocol and Related Documents, op. cit., p. 60

from the ratification date has the option to commence construction of a dam on the Kootenai River near Libby, Montana to provide storage to meet flood control, and other purposes in the United States of America.

Evaluation of the Canadian Decision to Adopt the
Non-Diversion Scheme

The adoption of a modified form of the International Columbia River Engineering Board's Non-Diversion Plan is an unusual development. Earlier it was pointed out that both the Dorr and the modified Dorr (McNaughton) Plans were more favourable for the total Columbia River system development and operation. Some insight into the rationale involved in rejecting the Dorr and modified Dorr Diversion Plans vis-à-vis the Non-Diversion Plan is gained by examining certain portions of the testimony presented before the Standing Committee on External Affairs by Honourable R. G. Milliston, the Minister of Lands, Forests and Water Resources of the Province of British Columbia.² The British Columbia departure from the objective of a mutual development of the Columbia River system as outlined in the International Columbia River Engineering Board report is set forth by the Minister in the following statement:

Much of the misunderstanding which has existed with regard to the merits for Canada of alternative schemes for

¹ Ibid., p. 66

² Canada, Standing Committee on External Affairs, Minutes of Proceedings and Evidence, Columbia River Treaty and Protocol, Numbers 5 and 6, op. cit., pp. 275-590.

Columbia River development appears to be due to misinterpretation of the 1959 report of the International Columbia River Engineering Board. This report was never intended to serve as a basis for the selection by Canada of the best sequence of Columbia River development from the point of national interest. The report was quite unsuited for this use by the time it was published because it was based on the consideration of the basin as a whole without regard to the existence of the International Boundary, and because it considered all projects as being in existence at the time they were being compared. A practical consideration of Canadian interests cannot ignore the existence of the International Boundary nor can a study of the economies open to us ignore consideration of practical sequences of project development. For these reasons British Columbia's policy has been largely based on the report completed in January 1959, for the Comptroller of Water Rights of British Columbia, by Crippen Wright Engineering Limited of Vancouver. This was a very comprehensive report in nine volumes, in which a very large number of alternatives were examined. . . .¹ (*italics mine*)

In effect since the Province of British Columbia has sole control over the development of its own resources and since the International Columbia River Engineering Board report did not consider projects designed to maximize net benefits for the province, British Columbia disregarded the report to the extent that its decisions on system development were based on reports prepared by its own consultants. The object of these reports was the maximization of net benefits for the Province. This is diametrically opposed to the terms of reference given to the International Joint Commission and in direct opposition to the vocal and written objectives of the American and Canadian governments. The singularly unfortunate aspect of this state of affairs is that the question of benefit maximization for the entire Columbia system was

¹ Ibid., pp. 284-285.

not reconsidered in any of the ensuing studies conducted by either the British Columbia, Canadian or American governments.

A Synopsis of the Treaty (Non-Diversion Scheme
of Development)

Given the British Columbia objective of maximizing net benefits from a provincial or regional point of view, the question remains on what grounds was the Non-Diversion vis-a-vis the Diversion Plan chosen. It is suggested that the decision was based as much on socio-political considerations as on economic grounds. One of the main economic considerations affecting the magnitude of the development schemes considered by British Columbia was the problem of obtaining sufficient capital. The initial investment required in Canada to instigate the first phase of the modified Non-Diversion Plan (Duncan, Mica and Arrow Lakes) was approximately \$345,000,000.00 for on site investment and approximately \$114,000,000.00 for transmission lines to the main load centers in British Columbia. Total investment in the first phase of development would amount to approximately \$459,000,000.00 while the ultimate development of the Columbia and Kootenay Rivers would amount to approximately \$1,5000,000.00. In return British Columbia would receive 1,477,000 kilowatts of power (9.057 billion kilowatt hours of energy at 70% load factor) and \$64,400,000.00 of flood control benefits in three series of payments staggered according to the completion date of each of the three

TABLE 3.--Approximate project and transmission investment costs¹

	At-Site Investment Cost	Transmission Investment Cost	Total
High Arrow Lakes	\$ 71,800,000	\$ 81,400,000	\$ 153,200,000
Duncan Lake	\$ 25,600,000	\$ 2,300,000	\$ 27,900,000
Mica Storage	\$247,200,000	\$ 30,100,000	\$277,300,000
Total Cost of Treaty Projects	\$344,600,000	\$113,800,000	\$458,400,000
Estimated Cost of Libby Flowage in Canada	\$ 10,000,000	0	\$ 10,000,000
Extensions to West Kootenay Area Power Developments	\$ 46,000,000	\$ 25,400,000	\$ 71,400,000
Totals	\$400,600,000	\$139,200,000	\$539,800,000

¹The Columbia River Treaty Protocol and Related Documents,
op. cit., p. 91

TABLE 4.--Estimated Canadian share of downstream power benefits for the year 1970¹

Project	Benefits at the Generators		Benefits Adjusted to a 70% load factor and Delivered to Loads (1)	
	Capacity in Kilowatts	Energy in Billions of Kilowatt Hours	Capacity in Kilowatts	Energy in Billions of Kilowatt Hours
High Arrow Lakes	771,000	4.240	684,000	4.194
Duncan Lake	145,000	0.657	118,000	0.724
Mica Storage	394,000	1.761	316,000	1.938
Total for Treaty Projects	1,310,000	6.658	1,118,000	6.856
Estimated Downstream Benefits in the West Kootenay area in Canada from Duncan and Libby Regulation			359,000	2.201
Total Benefits at Loads			1,477,000	9.057

(1) 6% transmission loss assumed for all power delivered to Vancouver and Kamloops areas. No losses assumed for power utilized in the Trail area. In the adjustment to a 70% load factor it is assumed that some Canadian capacity will be exchanged for additional energy.

¹ Ibid., p. 92

TABLE 5.--Flood control payments by the United States

Project	Payment Made at Commencement of Operation	Value of Payment when Invested in Columbia River Projects (5 ½ per cent Interest and 50-Yr. Amortization Period)
High Arrow Lakes	\$52,100,000	\$153,800,000
Duncan Lake	\$11,100,000	\$32,800,000
Mica Storage	\$1,200,000	\$3,600,000
Totals	\$64,400,000	\$190,200,000

¹ Payment for primary flood control only, no payment included for secondary flood control requirements.

² ibid., p. 95

resevoirs. Subtracting total flood benefits from total investment costs would leave a residual of approximately \$395,600,000.00 which British Columbia would have to raise if the first phase of development was to be undertaken.¹

The capital constraint faced by British Columbia was not as severe as indicated above since the Government of Canada offered to share one half of the costs of the storage dams (transmission facilities were excluded) on a basis of 'as and when' financing of future operation of the projects. Despite the ameliorating influence of the federal government the acceptance of the treaty proposals left British Columbia subject to three constraints: (1) a minimum of approximately \$200,000,000.00 of capital had to be raised to undertake the first phase of construction; (2) the British Columbia domestic market could not immediately absorb the amount of hydro-electric power which would be transmitted from the United States as a part of the Treaty agreements; (3) the federal government ban on the export of hydro-electric power to the United States eliminated any hope of selling surplus hydro-electric power.

A Comparison of the Non-Diversion vis-à-vis Dorr
Diversion Schemes of Development

It would appear that there were two basic engineering studies employed by British Columbia in reaching the decision to select the modified Non-Diversion scheme which was eventually

¹ Tables 3, 4 and 5 serve as the source for the figures noted in the above discussion.

incorporated in the Treaty (Refer to Tables 6 and 7.)

Note that reference to the data compiled in Table 6 by the British Columbia Waters Right Branch in 1960 indicates that on purely economic grounds a modified Non-Diversion Plan (L-1 would not be favoured over the Dorr Diversion Plan of development (N-2). Sequence N-2 requires \$61,300,000.00 more investment than sequence L-1 but the total present value of the cumulative return from the larger investment results in a net difference of \$26,400,000.00 in favour of the Diversion Plan (the opportunity cost of adopting the Non-Diversion type plan).¹

A more accurate comparison of the Dorr Diversion vis-a-vis the Non-Diversion Plan is obtained by comparing the sequence labelled N-2 in Table 7 with sequence MC-6²; Reference to Table 8 indicates that the Treaty Plan results in cumulative surplus to 1981 of \$14,200,000.00 while sequence

¹This is derived by subtracting the present value of N-2 from L-1 for the relevant time stream, given a discount rate of 5.5%. This difference amounts to approximately \$23,000,000.00 while the difference in surplus cumulative to 1980 amounts to \$3,400,000.00

²For all intents and purposes MC-6 represents the projects, credit position and scheduling associated with the proposal adopted by British Columbia and eventually incorporated in the Treaty. A detailed explanation of the assumptions and variations contained in the other five plans may be found by consulting Krutilla, op. cit., p. 110. It should be noted that the six projects involve variations in the sequence and timing of the so-called "non-diversion plan". MC-6 was suggested as the most feasible sequence given the American negotiating position.

N-2 has a surplus of \$110,000,000.00. Table 8 indicates that the disparity in the present value of the fifty year stream of net surplusses results in a net advantage of N-2 over MC-6 of \$52,300,000.00. In total N-2 vis-à-vis MC-6 results in a \$148,700,000.00 surplus in favour of the former sequence. (The net difference between N-2 and MC-6 given the cumulative surplus and the present value of the respective time streams in 1981.)

The above results suggest that from a purely economic point (at least from the analysis conducted by British Columbia's own engineers) the only possible justification of the Treaty project vis-à-vis the Dorr Diversion project selection would occur in the situation where the capital constraint was so severe that the additional \$54,600,000.00 investment required by sequence N-2 vis-à-vis MC-6 could not be undertaken by the British Columbia government. There is no apparent evidence to suggest that this severe a capital shortage was experienced by the Province.

In the foregoing discussion it was concluded that while the availability of capital has posed a problem for the British Columbia government this constraint by itself should not have been sufficient to force the adoption of the Treaty scheme of development. It is suggested that recourse towards finding a more acceptable reason for this action must be found in the examination of the socio-political rather than the purely economic considerations involved in each of the

TABLE 6.--Comparative surplus or deficits of seven alternative sequences of upper Columbia-Kootenay storage development

(million dollars)		Surplus (+) or Deficit (-)			
Sequence	Cumulative investment by completion (1980)	Annual revenue on completion (1980)	Annual cost on completion (1980)	Equal annual increments (1980-2010)	Cumulative to date of completion (1980)
1) K-2	1,315.5	115.9	100.1	+15.8	+13.6
2) L-1	1,201.1	109.7	91.5	+18.2	+59.7
3) M-1	1,139.2	109.7	91.0	+18.7	+22.4
4) N-1	1,262.4	109.7	96.0	+13.7	-1.0
5) N-2	1,262.4	115.9	96.0	+19.9	+63.1
6) P-3	1,111.4	106.7	85.2	+21.5	-41.0
7) Q-2	1,262.4	115.9	95.0	+19.9	-2.5

1) Arrow, Dorr-Bull River, Duncan, and Mica with 275 mw export and accelerated to meet U. S. load growth.

2) Arrow and Duncan, followed by Libby and Mica pooled: to fit Canadian load growth.

3) Arrow, Duncan, Mica, and Libby, with Mica storage in two stages to precede Libby.

4) Duncan, Dorr-Bull River, and Arrow: to meet Canadian load growth.

5) Duncan, Dorr-Bull River, and Arrow: with 275 mw export, accelerated to meet U. S. load.

6) Duncan, Dorr-Bull River, and Mica: accelerated to meet U. S. load growth.

7) Duncan, Dorr-Bull River, Arrow, and Mica: accelerated to meet U. S. load with 275 mw export.

TABLE 7.--Comparative Surplus or Deficits of Six Alternative Sequences of
Upper Columbia-Kootenay Storage Development

Sequence	(million dollars)				Net Surplus (+) or Deficit (-)	
	Cumulative investment by completion (1980)	Annual cost on completion (1980)	Annual revenue on completion (1980)	Refinanc- ing costs by completion (1980)	Equal annual increments commencing (1981)	Cumulative to year after completion (1981)
1) MA-5	1,234.0	93.2	113.3	40.9	+17.9	-19.4
2) NC-5	1,234.0	93.2	113.3	38.4	+17.6	-25.3
3) NB-5	1,234.0	93.2	113.3	48.0	+16.1	-52.2
4) DC-5	1,234.0	93.2	113.3	2.0	+22.3	+59.6
5) VB-5	1,284.0	96.9	119.1	17.4	+22.4	+25.3
6) NC-6	1,207.8	92.9	115.9	21.4	+20.6	+14.2

TABLE 8.--Comparison of realizable results of British Columbia's East Kootenay storage option¹

Year	N-2		MC-6	
	Revenue minus costs ^a	Interest on cumulative difference at 5.5%	Net surplus (+) or deficit (-)	Cumulative surplus (+) or deficit (-)
1955	-5.5	--	-5.5	-5.5
1966	-10.0	-0.3	-10.3	-12.2
1967	-1.7	-0.9	-2.0	-15.1
1968	+2.0	-1.0	+1.0	-15.4
1969	+7.7	-0.9	+6.8	-10.4
1970	+5.1	-0.6	+4.5	-20.3
1971	+7.1	-0.3	+6.8	-25.9
1972	+11.7	+-.1	+11.8	-24.1
1973	-1.4	+0.7	-0.7	-28.5
1974	-1.2	+0.6	-0.6	-33.0
1975	+2.3	+0.6	+2.9	-39.7
1976	+6.7	+0.8	+7.5	-41.2
1977	+10.3	+1.2	+11.5	-39.4
1978	+9.6	+1.8	+11.4	-34.9
1979	+15.6	+2.4	+18.0	-28.0
1980	+20.2	+3.4	+23.6	-5.4
1981	+20.2	+4.7	+24.9	+14.2
1982	+20.2	+6.1	+26.3	+36.0
Present value of 50 year stream of net surplus or deficit				\$268.1
Less overestimate of flood control benefits				-49
Net advantage of N-2 over MC-6				\$ 52.3

^aN-2 sequence annual costs were systematically reduced by an amount equivalent to the difference between annual costs of MC-5 and MC-6, reflecting the savings from substitution of annual service charges for standby in lieu of Canadian construction of the east-west standby transmission facilities.

schemes of development.

Perusal of the testimony presented to the Standing Committee on External Affairs by the British Columbia Minister of Lands, Forests and Water Resources indicates that British Columbia was extremely reticent about the inundation and population displacement resulting from the Dorr Diversion Plan proposals. Both the Non-Diversion and Dorr Diversion Plans involved flooding in the Arrow Lakes regions; however, the latter plan would result in an additional inundation of approximately 70,000 acres in the Upper Kootenay and Columbia valleys. Additional flooding would: (1) impose an effective 150 mile long barrier to east-west transportation stretching from near the international border to Luxor; (2) displace approximately 1,600 people from their present places of residence; (3) cause an annual loss in big game expenditure of approximately \$8,000,000.00 yearly.¹

From an economic point of view the evaluation of the majority of the costs involved in inundating relatively large numbers of acres in the East Kootenay valley are a simple matter and it can be assumed that they could easily be included in the normal cost-benefit valuations of the various projects. It is quite evident, however, that certain of the intangible benefits and costs cannot be measured adequately. (Aesthetic, political and a number of recrea-

¹ Canada, Standing Committee on External Affairs, Minutes of Proceedings and Evidence, Columbia River Treaty and Protocol, No. 5, op. cit., p. 235.

tional gains and losses.) At the risk of some repetition it should be remembered that the international Columbia River Engineering Board cost-benefit analyses are not normal in the sense that only hydro-electric and flood control benefits are credited, though the cost side of the analyses are fairly inclusive. Given the inadequate nature of the cost-benefit analysis used and given the impossibility of evaluating many of the costs and benefits even in a conventional analysis the British Columbia Government elected to opt for the modified Non-Diversion Plan over the Dorr Diversion Plan. From the previous analysis it was noted that the net gain derived from implementing the Dorr vis-a-vis the Treaty project was estimated at \$148,700,000.00. It is evident that on the basis of the foregoing argument that the adoption of the Treaty scheme must be classified as one of the most expensive pieces of subjective evaluation in the recent history of resource development in the Dominion.¹

¹ It should be noted that General McNaughton suggested to the Committee on External Affairs that the agreement by the Federal Government to the Non-Diversion Plan involved a reversal of the initial federal support for the Dorr Diversion Plan. The reversal of their position supports the British Columbia observation that it is the Province which has the ultimate jurisdiction over its natural resources and not the Federal Government.

CHAPTER V

THE ECONOMIC IMPLICATIONS OF THE CHANGES INCORPORATED IN THE PROTOCOL TO THE COLUMBIA RIVER TREATY

The Columbia River Treaty was signed in January 1961; however, the implementation of the projects outlined in the Treaty did not commence until a number of changes, specifications and interpretations to the Treaty were agreed upon and incorporated into the Protocol to the Treaty some three years later. In the previous chapter it was argued that from a purely economic view point the framework on which the key Treaty proposals were formulated was generally unacceptable. In the following discussion it will be pointed out that the changes which occurred in the interlude between the signing of the Treaty and the signing of the Protocol were of sufficient magnitude to require a renegotiation and re-appraisal of the joint American-Canadian Treaty scheme for developing the Columbia River basin. Examination of the quantification of certain of the Treaty agreements as recorded in the Protocol will not be undertaken.

Changes in the British Columbia Position

At the time of the signing of the Columbia River Treaty on January 17, 1961, British Columbia was faced with

the problems of: (1) utilizing the hydro-electricity transmitted to the province by the United States; (2) marketing the power within the domestic economy given private ownership of the electrical utilities; (3) financing the joint development of both the Columbia and Peace River projects (commonly called the two-river policy of development); and (4) resolving problems arising with the Federal Government over the amount of control each of the two governments were to exercise over Columbia River power policy and other associated matters.

Hydro-electricity as a Vehicle of Growth

A brief examination of the hydro-electric potential of British Columbia is necessary to understand the modus operandi employed by British Columbia in resolving these problems. Reference to Figure 7 indicates that in 1964 the estimated potential of undeveloped hydro-electric power sites in the province amounted to approximately 22,000,000 kilowatts of prime power or 33,000,000 kilowatts at 65% load factor. By comparison, 96% of the electrical energy demands of the Pacific Northwest were met by slightly over 15,000,000 kilowatts of the purported 35,000,000 kilowatt potential on the mainstem of the Columbia River in the United States. In the Province of British Columbia total hydro-electric developments amounted to approximately 7.7% or 2.6 million kilowatts of capacity (0.8 million kilowatts were generated by thermal means).

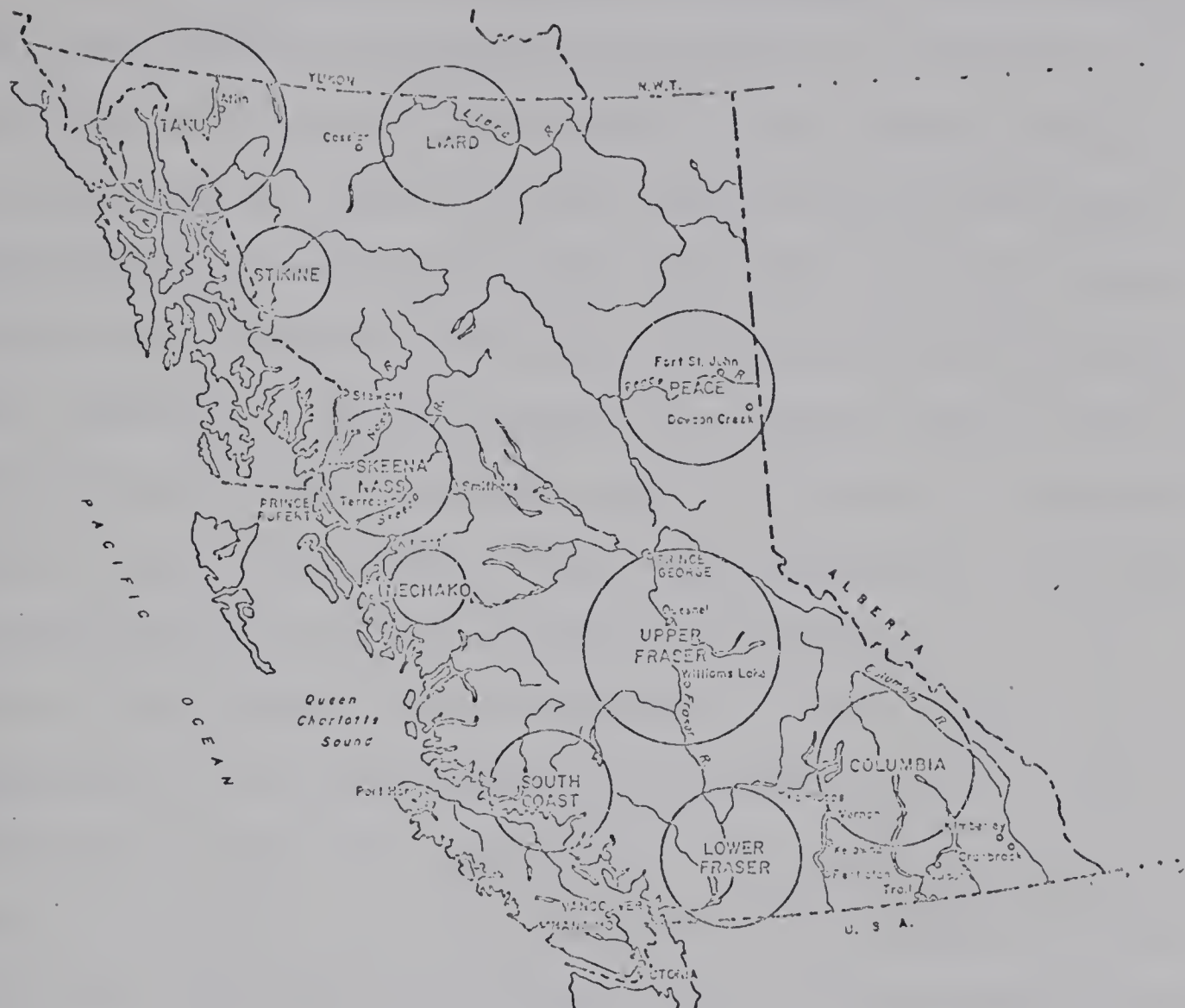


FIGURE 7.--Undeveloped hydroelectric resources in British Columbia¹

Total 33,845,000 Kw.

Capacities to meet 65% load factor

Taku	5,620,000 Kw.	Nechako	925,000 Kw.
Liard	3,650,000 Kw.	Upper Fraser	6,540,000 Kw.
Stikine	1,370,000 Kw.	Lower Fraser	3,080,000 Kw.
Skeena-Nass	2,630,000 Kw.	South Coast	2,390,000 Kw.
Peace	3,710,000 Kw.	Columbia	3,880,000 Kw.

¹The Columbia River Treaty and Protocol, Issued by the Departments of External Affairs and Northern Affairs and National Resources (Ottawa: Queen's Printer, April 1964), p. 17.

On the basis of historical evidence it is estimated that the electrical energy requirements of British Columbia will double approximately every twelve years. Between 1945 and 1954 a 9% per annum rate of growth was experienced while between 1954 and 1962 the total energy requirements doubled from seven to fifteen billion kilowatt hours or by 10% per annum. The growth rate in the period between 1954 and 1962 must be deflated to approximately 6.2% since 3.8% of the increase resulted from the installation of the Alcan smelter at Kitimat.¹ It is evident that given the circumstances in 1961 where the majority of the hydro-electric generation sites in the vicinity of the lower mainland and the Vancouver load centers had been almost fully developed, British Columbia had to undertake immediate development of additional hydro-electric sites.²

Two alternative schemes of development were evident to the British Columbia government by 1961. The first centered around the hydro-electric generation made available through the Columbia River Treaty (the downstream hydro-electric benefits from the United States and the possible generation of some 1,820,000 kilowatts from the Mica Creek installation). The other scheme resulted from the mid 1961

¹By way of comparison the rates of growth per annum of electrical energy requirements in the American Pacific Northwest amounted to approximately 11% between 1945 and 1957 and 4½% between 1957 and 1962. The projected rate of increase between the present and 1980 is estimated at 6½%.

²Ibid., pp. 15 - 18.

report of the British Columbia Energy Board which noted that it was entirely feasible as a public undertaking to develop the hydro-electric potential of the Peace River. It was noted that compared to the Columbia River Treaty proposals the cost of the power from both sources would be identical if the flood control benefits of the Columbia were excluded from consideration.¹ The report went on to note that a simultaneous development of both projects would result in a supply of hydro-electric power far in excess of British Columbia's domestic needs. It was suggested that this problem could be resolved by selling the hydro-electric benefits resulting from the Columbia Treaty agreements to the various hydro authorities in the American Pacific Northwest. The major point of consideration in the sale of this power was the fact that no transmission facilities would have to be built in Canada.^{2 3}

¹ In his submission before the Standing Committee on External Affairs, the Honourable R. G. Williston, British Columbia Minister of Lands, Forests and Water Resources argued that a comparison of the Peace and Columbia projects based on the exclusion of the credit for flood control benefits to the Columbia projects was justified because the cost of the Arrow Lakes project had risen from \$66,000,000.00 to \$130,000,000.00. He pointed out that it was just 'coincidental' that the increase in cost (\$64,000,000.00) equalled the total flood control credit. On the basis of this turn of events British Columbia felt the two projects were comparable in all respects. Canada, Standing Committee on External Affairs, Minutes of Proceedings and Evidence, Columbia River Treaty and Protocol, No. 5, op. cit.

² Ibid., pp. 291-292.

³ Krutilla, op. cit., p. 156.

After examining the main proposals of the British Columbia Energy Board as outlined above the British Columbia government took over the ownership of the privately owned electric utilities in the Province by passing the Power Development Act on August 3, 1961. Two implications follow from this action. First, the establishment of a Crown power monopoly solved the problem of public ownership and development of the major hydro-electric resources and private control of the marketing of the electrical output. Second, the financial problems involved in private development of the Peace River Project were lessened by placing the financial resources of the Province behind the development. It is suggested that the prime motivation underlying the British Columbia government's nationalization of the British Columbia Electric Company was due to the Government's belief that the provision of relatively low cost power in the interior of the Province would lead to a large number of external economies. There is some evidence to suggest that it would not have been feasible for the British Columbia government to assume that either the magnitude or the temporal sequence of the investment required to develop the hydro-electric resources of the province would be undertaken by the private utility. A report prepared by British Columbia Engineering Company Limited¹ noted that there were enough coal resources in the Hat Creek area of British

¹Ibid., p. 160.

Columbia to provide an output of two million kilowatts of power for the service life of thermal electric generating stations at costs comparable to any other source of power in British Columbia. Utilization of these thermal generation units by the British Columbia Electric Company would provide relatively inexpensive power to the main load centers in British Columbia in the size of increments designed to satisfy the demands of the domestic markets. It is evident that it would not be to the company's advantage to undertake the large investment required to develop the Columbia River (particularly the Dorr or McNaughton Plans) or the Peace River hydro-electric generation proposals, given the limited size of its domestic market and the federal ban on the export of power. It would seem that on the above basis the 'take-over' of the British Columbia Electric Company was based on the simple fact that a private company will not undertake large capital commitments when one of the main consequences of the investment is to be found in the external economies accruing to the region in general. The market mechanism does not provide a means for compensating the investor in this case; thus, considerable support can be given to government control, assuming that the government's objective is to maximize the region's rate of growth over a certain time period.

On the basis of the available evidence it appears that the British Columbia government predicated the future economic development of the Province on the simple assertion

that given large amounts of low cost hydro-electric power concomitant industrial development will inevitably appear. Support for this conclusion is drawn from two statements which can be considered as the prime determinants of British Columbia development policy. The first statement deals with the objectives of British Columbia power development, the second deals with the role power has in furthering regional development particularly with respect to its role as a basic means for extending the province's industrial frontier.

British Columbia power policy has three main objectives:

- (1) To develop British Columbia's economic hydro power resources as rapidly as possible by encouraging increased use of electrical energy in the province and by seeking markets elsewhere in Canada and the United States;
- (2) To reduce the cost of electrical energy in British Columbia to the greatest extent possible, by developing the best projects and sequences of projects first;
- (3) To achieve these objectives with a minimum of displacement of population, disruption of transportation facilities and destruction of other resources.¹

The British Columbia government's appraisal of the Peace River Project in meeting the objectives of their power policy as well as serving as a vehicle for promoting the development and utilization of the natural resources contained in the northern and central interior portions of the province is defined in the following statement:

Low cost power has never been available in this region, which with its abundance of natural resources, appears to be on the threshold of rapid expansion. The devel-

¹Canada, Standing Committee on External Affairs, Minutes of Proceedings and Evidence, Columbia River Treaty and Protocol, No. 5, op. cit., p. 285.

opment of this area is a primary objective in British Columbia's power policy. Columbia development would make no contribution towards meeting the power requirements of the northern area, and the supply of power in this area was not provided for in any of the studies of the cost of power from the Columbia.

The basic question which does not appear to have been answered is given the natural resources of the area, will new investment take place? If so, what will be the nature of the investment and what will be its effect in terms of employment, income and government service requirements in the area?

The Impasse Between the Governments of Canada
and British Columbia

It is evident that by the end of 1961 British Columbia was no longer prepared to implement the terms of the Columbia River Treaty. The basic tenet of the Treaty and the basic point of contention between the province and federal governments rested on the transmission of the Canadian share of the downstream power benefits into British Columbia. In order to realize the objectives of its two river policy--low cost power from the Mica site and development of the Peace River and the central interior portions of the province--British Columbia needed to sell its share of the increase in power generation in the United States for a lump sum payment. By achieving this goal the hydro-electric generation from Mica could be phased into the British Columbia power system

¹ Ibid., p. 292.

after the Peace River power supply had been absorbed, while the power originating from the American plants could be easily handled by domestic market requirements after the expiration of a twenty or thirty year contract sale. Thus, by selling the power benefits resulting from the Columbia River Treaty, British Columbia could carry out its prime objective, the development of the natural resource frontier, without eventually sacrificing any of the hydro-electricity derived from the Columbia River Treaty agreements. The British Columbia objective was to obtain a long and short run gain (development of the interior and a substantial amount of low cost power) by trading off a short run surplus of power.

The historical record indicates that negotiations between the two governments were stalemated for approximately two years. After a change in federal government the impasse was broken and an agreement was signed in 1963 which designated the respective responsibilities and duties of Canada and British Columbia with respect to the Columbia River Treaty.¹ Three months after this agreement the Minister of Trade and Commerce announced a National Power Policy in the House of Commons which embraced two essential concepts:

- (a) To encourage development of large low-cost power sources and to distribute the benefits thereof as widely as possible through interconnection between power

¹ "Canada-British Columbia Agreements", The Columbia River Treaty and Protocol, op. cit., p. 170.

systems in Canada, and (b) To encourage power exports and interconnections between Canadian and United States power systems where such might induce early development of Canadian power resources.¹

The final valuation of the Canadian portion of the downstream power benefits agreed to in the Protocol to the Columbia River Treaty resulted in a lump sum payment to the Province of British Columbia of \$254,000,000.00 (United States) on October 1, 1964. Table 9 indicates that after all three storage reservoirs are completed there would be an estimated surplus of \$53,400,000.00 (Canadian value) which could be used to pay one half the cost of machining Mica for hydro-electric generation.²

The Impact of Technological Change on the Treaty and Protocol

British Columbia's action in undertaking immediate development of the Peace River Project (estimated completion date is 1968) was based on technical advances in the long distance transmission of hydro-electric power. The magnitude of this change is easily illustrated by noting that

¹ Ibid., p. 19.

² The estimated cost of power generation at the Mica site during the thirty year period of downstream power sales is approximately 1.5 mills per kilowatt hour. A unilateral development of the Mica site by Canada would result in an on site generation cost of approximately 4 mills per kilowatt hour. In terms of dollar valuation this amounts to a saving of \$16,000,000.00 per annum until the year 2003. It is estimated that beyond this time a saving of approximately \$13,000,000.00 a year will be realized. Ibid., p. 102.

TABLE 9.--Comparison of Revenues and Costs -- Columbia River Treaty Projects¹

A. Payments to be made by United States of America

<u>Payment for</u>	<u>Amount of Payment</u> <u>\$Millions (Can.) at date of</u>	<u>Value on 1 April 1973</u> <u>\$Millions (Can.)</u>
Power benefits	274.3 1 Oct. 1964	416.1
Flood Control		
Duncan	12.0 1 April 1964	15.3
Arrow	56.3 1 April 1964	68.4
Mica	1.3 1 April 1964	1.3
	Total	501.1

B. Capital Costs of Projects

<u>Project</u>	<u>Capital Cost</u> <u>at in-service</u> <u>\$Millions (Can.)* date of</u>	<u>Cost on</u> <u>1 April 1973</u> <u>\$Millions (Can.)</u>
Duncan Storage	33.3 1 April 1968	42.5
Arrow Storage	129.5 1 April 1969	157.4
Mica Storage	245.2 1 April 1973	245.2
General Costs	2.6 1 April 1973	2.6
	Total	447.7

C. Surplus

Total payments less total capital cost, i.e.

$$A - B = \$53.4 \text{ million}$$

This surplus represents approximately one-half the cost of Mica at-site generation.

NOTE: (1) Interest rate assumed at 5 per cent both on costs and investment of payments.

(2) Exchange rate assumed to be \$1.00 (U.S.) - \$1.08 (Canadian)

*Includes interest during construction at 5 per cent per annum.

¹ Ibid., p. 96

the existing transmission lines in 1961 were rated at 132 kilavolts while the Peace River line will carry 500 kilavolts.¹

The importance of extra high voltage long distance transmission of hydro-electric power is twofold. First, large relatively inaccessible hydro-electric resources can be utilized. Second, inter and intra regional transmission grids can easily be established. These two factors are a prime feature of the Peace River Project. The transmission line from the Peace River Project will proceed almost directly southward through Prince George to a junction with the existing grid in the southern portion of the province. Since the major portion of the province's undeveloped hydro resources will be traversed by this transmission line or will be directly north of the Portage Mountain site, the obvious development will be to utilize the Peace River transmission line as the main backbone of a provincial grid system (the generation from Mica would be tied into it in approximately 1973 or 1980). It is estimated that approximately one half

¹The magnitude of the technological breakthrough not only in the size but in the distance which hydro-electricity can be transported was indicated by R. W. Williston in his testimony to the Standing Committee on External Affairs, Minutes of Proceedings and Evidence, Columbia River Treaty and Protocol, No. 5, op. cit., p. 295.

. . . many examples of 500,000 volt transmission lines will be in service in Canada and the United States, and, similarly, transmission distances will have advanced far beyond that of the proposed Peace River transmission lines. What was beyond the fringe of design experience five years ago will, by the time of completion of the first transmission circuit from Portage Mountain in 1968, have become almost commonplace. The 560-mile, 735,000 volt transmission line from the Manicouagan 5 dam in Quebec will by then be in service, and a 950-mile, interconnection between California and the Columbia River power plants seems now to be virtually assured.

of the \$700,000,000.00 investment of the first stage of development will be spent on the construction of this line.

There are a number of external economies derived from utilizing the Peace transmission lines as the main tour de force in the provincial grid. One excellent example of such a case occurs in the development of certain projects on the Fraser River and its tributaries. Flood regulation on the Fraser River is absolutely necessary if adequate protection is to be given to the inhabitants of the communities located in the Fraser flood plain in the lower mainland. The British Columbia government conducted a number of multi-purpose flood control and power generation studies and found that adequate flood control could be provided by the construction of a number of holding resevoirs. In addition to providing adequate flood control these resevoirs will be capable of generating hydro-electricity at a cost of five mills per kilowatt hour if transmission lines from its project sites were connected to the Peace River transmission line. Without such a transmission line it is evident that given the prevailing rate of four mills per kilowatt hour in the southern mainland that the addition of transmission costs to the five mill rate would retard the speed with which Fraser River projects would be undertaken.

The Effect of Long Distance Power Transmission
on the Treaty Projects in Canada

The development of a provincial power grid centered

around the Peace River project has serious implications for the series of storage reservoirs and hydro-electric sites set out in the Columbia River Treaty and Protocol. This results from the fact that the interconnection of the Peace and Columbia hydro system would allow large blocks of secondary energy on the Columbia River to be 'firmed-up' and sold.

With only the Mica Project and Downie Creek and Revelstoke Canyon run-of-the-river projects considered as added to the existing facilities on the Columbia the load-carrying capability of the Peace and Columbia systems, if interconnected as above, would be increased by a million kilowatts of firm power.¹

It is evident that given the existence of low cost thermal generation units at Hat Creek and the existence of the Peace River storage and generating capacity that a realistic appraisal of the optimal combination of resources used for hydro-electric generation becomes entirely different from those envisaged under the 1961 Columbia River Treaty frame of reference. It is strongly suggested that since the above information was available in 1963 at the time the negotiations underlying the Protocol were being carried out that on purely economic grounds both the American and Canadian negotiating teams were extremely inept in not carrying out an entire re-appraisal of the range of technical alternatives available for developing the resources of the Columbia Basin in such a manner as to maximize the net benefits for both

¹Krutilla, op. cit., p. 159

countries.

A cursory examination by J. V. Krutilla of only one of the many possible alternatives made possible by an interconnection of the Peace and Columbia River hydro-electric systems supports this conclusion. Krutilla states:

High Arrow storage is a pure storage, not suited to conversion to hydro peaking as the demand for storage gradually declines. Its inclusion in the original Treaty in 1960 was at least partially justified by the short lead time required to bring it into the system and the expectation that load growth would leave a gap in power supply which High Arrow alone could fill in time . . . Coordinated operations of the Peace River storage and integrated Columbia hydro facilities by means of transmission facilities from both developments to the Vancouver, B.C. and/or similar Northwest power market areas would accomplish at little additional cost the purpose the Arrow Lakes storage was intended to fulfill in the regional power system. In fact, the increase in firm power load which such coordinated operations could accomplish would greatly exceed the incremental contribution of the Arrow Lakes storage, and at a savings in cost nearly equivalent, to the outlays for High Arrow.¹

In effect, if the Treaty is to be considered as a mutual undertaking then given the Peace River project as a fait accompli the achievement of an optimal hydro-electric scheme must rest on a re-evaluation of the Treaty proposals. The importance of this conclusion is best illustrated by Krutilla's observation that even given the present Treaty scheme, "Libby's operation coupled with the coordination of the Peace and Columbia systems operation would have substituted satisfactorily for the High Arrow-Duncan storage and an efficiency gain (economy) of about \$150,000,000.00 would have been realized."² (italics mine)

¹ Ibid., p. 193.

² Ibid., p. 193

Earlier it was pointed out that British Columbia refused to consider the implementation of either the Dorr or McNaughton schemes of development despite their superiority over the Treaty proposals. Krutilla notes that given the intertie between the Peace River and Columbia projects, the substitution of the Dorr-Bull River sites in lieu of the relatively expensive Libby project coupled with the elimination of the Duncan, High Arrow projects would result in a \$250,000,000.00 to \$300,000,000.00 gain over the Treaty agreements.¹

The criticism of the decision of both the parties to the Protocol not to re-appraise the entire list of projects set out in the Columbia River Treaty of 1961 was primarily based on the change in the parameters concerned with the long distance transmission of hydro-electric power in Canada. If this consideration is extended to the proposed changes in long distance transmission of power in the United States, it completely vitiates any claim for economic realism that could be given to the Treaty and Protocol agreements.

The Effect of Long Distance Power Transmission
on the Treaty Projects in the United States

During the negotiations surrounding the Protocol it became evident to American interests that agreement would be reached on the sale of the Canadian power entitlement. The

¹Ibid., p. 193.

absorption of this power posed certain short run problems in the Pacific Northwest. The chief reason for these problems arose from the fact that the projected growth in power demand had not materialized and a substantial start on a number of hydro-electric and flood control projects had already been undertaken.¹ This short run surplus position in the Pacific Northwest furthered tentative plans for the development of an intertie between the Northwest, California and Southwest power systems. By the time the exchange of ratifications of the Columbia River Treaty and Protocol had occurred in 1964 an agreement on the establishment of an intertie had been reached between the respective hydro authorities in each area.

The agreement to establish an intertie between the Southwest and Pacific Northwest completely changed the parameters on which the Columbia Treaty was formulated. The major factor leading to American participation in the Treaty negotiations was the inadequacy of the storage facilities on the American portion of the Columbia River. Canadian storage appeared to be a necessary condition if relatively short run future power demands were to be met. It was realized that for any intermediate or long term consideration the electric power loads of the region would have to be met from conventional or nuclear fuelled thermal

¹ One of the more interesting developments was the commencement of construction on the Hanford New Production Reactor for the thermal generation of electricity.

generating stations. The immediate construction of the intertie would almost destroy the importance of Canadian storage in meeting short run power demands. Given the intertie, unregulated stream flows (in this case excess stream flows) on the Columbia could provide secondary energy as a fuel replacement in the primarily thermal systems in the Southwest. Similarly during periods of adverse stream flows the thermal units in the Southwest could provide sufficient power to maintain a high level of prime power capacity in the Northwest. In addition, given the difference in the main load periods of each area, each of the systems would be mutually re-enforcing with respect to their ability to fulfill peak demands. The hydro-electric facilities of the Northwest would play a key role in this respect since for all intents and purposes there is almost an instantaneous delivery of power from a hydro-electric system. The final major benefit resulting from an intertie of this nature is that given the complementary nature of the two regions the total reserves required for both systems would be less than the total required for each individually.

It is evident that given the above implications resulting from the intertie and the complementary relationship existing between the Peace River Project and any concomitant hydro-electric development in the Upper Columbia basin, that the agreements incorporated in the Columbia River Treaty and Protocol needed to be completely re-evaluated. The

decisions incorporated in the Treaty and Protocol were based upon ceteris paribus assumptions that held for the first decade and a half of the International Columbia River Engineering Board investigations. The advent of a technical advance in long distance power transmission in the early 1960's and an inability on the part of the negotiating parties to explicitly recognize maximization of the rate of regional growth as their main goal contributed to the achievement of a mutual political concensus between the negotiators rather than a mutual resolution of the economic problem involved in choosing an optimal plan for the development of electric power in the Columbia River Basin.

CHAPTER VI

CONCLUDING OBSERVATIONS

The main criticisms in this thesis are chiefly of a methodological nature. They are mainly addressed to the problems which occur when the conventional positive approach to economic analysis is intertwined with a number of normative considerations--the previous criticisms of the International Joint Commission's Report on Principles are a case in point--and to the problems arising from a refusal by a number of government and international agencies to furnish the analysis required to answer their prime directives. (For example, the criticisms of the International Columbia River Engineering Board report vis-à-vis their terms of reference.) There is little point in conducting a further examination of these criticisms; however, there is a need to re-emphasize their import. These types of criticisms are directed towards errors commonly associated with poorly trained or poorly advised personnel filling positions requiring competent economic analysts. It is suggested that this strongly implies that the position of economics in the hierarchy of applied sciences will continue to be of a relatively low ranking if the transition between the commonly accepted theoretical techniques and the application of these techniques

remains as widely spread as the foregoing criticisms of the Columbia River Treaty and Protocol would indicate. The reputation of a science must eventually rest on its practitioners. It is instructive to note that while the pattern of a logical discourse has been the standard format in economic theory for a number of decades, an examination of some of the economic analyses underlying the Columbia River Treaty and Protocol would lead one to conclude that it had not yet been discovered let alone implemented.

Economic Growth and the Allocation of Natural Resources

The major criticism contained in the thesis is centered around what may be called the 'recognition problem'. This problem results purely and simply from the fact that neither of the parties to the Treaty and Protocol realized that the basic question involved in a joint development of the hydro-electric resources of the Columbia River basin was regional economic growth. An examination of the chain of events underlying British Columbia's decision to utilize the Peace River Project to develop the northern and central portions of the province indicates that British Columbia considered the Columbia and the Peace River projects as substitute rather than complementary developments. Instead of stating regional growth as the prime objective and utilizing both projects as a means of achieving this end British Columbia tended to 'trade off' hydro-electric development on the Columbia for

the hydro-electric and growth considerations embodied in the Peace River project. The short comings of this basic mistake was illustrated by noting that a complementary development of these two projects would lead to gains amounting to \$150,000,000.00 to \$250,000,000.00 of those realized from the Treaty agreements. It should be noted that the inadequacy of British Columbia's appraisal of the effect of major hydro-electric developments and long distance transmission on the rate of growth of regional per capita income in the province is well illustrated by the fact that the province has not undertaken any type of an analysis which would enable it to evaluate the economic effects on the provincial growth rate of an intertie between the Pacific-Northwest-Southwest grid and the Upper Columbia-Peace River grid in British Columbia.

It has been indicated that any consideration of regional growth was effectively repressed in terms of being explicitly included in either the Treaty or Protocol. This is a singularly unfortunate achievement given the observation that the agreements contained in the Treaty and Protocol will have a substantial impact on the type and rate of regional development which will be experienced in British Columbia and Canada (given the eventual formulation of a national grid) in the ensuing years. Investment in the field of natural resources particularly in hydro-electric resources are characteristically

large and of a long term nature. In a country with a large abundance of natural resources and a relative shortage of capital long run allocation decisions formulated under short run capital constraints may well be traded off in terms of a long run misallocation of resources. It does not require much cognitive ability to realize that a continuation of this type of approach will eventually result in a situation in some future time when all of the existing resources have been successfully misallocated.

Cost-Benefit Analysis and Regional Resource Development

There is one conclusion of some methodological significance which can be drawn from this thesis. It is suggested that the conventional analytical procedure which has been followed by the American Army Corps of Engineers, by the International Joint Commission and by almost all analysts in the field of water resources, should be very carefully re-appraised and in fact for certain purposes be discarded. Cost-benefit analysis is based on a comparative static general equilibrium micro-economic framework. It is evident from the discussion surrounding the 'recognition' problem that this type of analysis is less than useful for regional growth consideration (that is, changes in employment, rates of increase in regional gross national product etc.). The assumptions underlying this model--full employment, perfect capital mobility, no

redistribution of income etc.--remove from consideration the factors (changes in parameters) which are of prime importance to the economic analyst. Even if a workable dynamic general-equilibrium micro model could be utilized this type of an orientation is still towards the effects of the relevant changes on the individual firm, consumer, industry or the relevant costs and benefits involved in building a particular hydro-electric site.¹

¹Reference to Eckstein, op. cit., pp. 24-46 indicates that one of the major proponents of cost-benefit analysis is certainly well aware of the aforementioned problems. One of the basic developments emerging from Eckstein's work is the establishment of a cost-benefit criterion which supposedly compensates for the divergence between the perfectly competitive, static general equilibrium model and a dynamic imperfectly competitive general equilibrium model. He suggests "that only projects are undertaken in which capital yields as great as it would in its alternative employments: let the government use a relatively low interest rate for the design and evaluation of projects. but let projects be considered justified only if the benefit-cost ratio is well in excess of 1.0" Otto Eckstein, Water-Resource Development (Cambridge, Massachusetts: Harvard University Press, 1961), p. 101.

It is suggested that while Eckstein's criterion may serve as a rough practical approximation for avoiding government investment in projects which are highly infeasible it does not provide a format for choosing projects on the basis of maximizing the net benefits derived from a certain level of investment in a region where the investment projects are highly interdependent and capable of generating a number of backward and forward linkages. Support for this contention can be derived from a later article by Eckstein in which he admits that the benefit-cost framework is inadequate for dealing with the problem of regional development. He points out that all the relevant tools of economic analysis (regional input-output analysis, location analysis, regional income analysis) need to be used. Otto Eckstein, "Benefit-Cost Analysis and Regional Development", Regional Economic Planning, Edited by W. Isard and J. H. Cumberland (Paris: O.E.E.C., 1960), p. 368.

It is suggested that cost-benefit analysis should be strictly confined to individual project selections and not to an evaluation of a number of projects which have wide spread effects on prices and the employment of factors of production. At the risk of opening Pandora's box it is suggested that in large scale highly interdependent projects such as those set out in the Columbia River plans of development, that individual cost-benefit analyses of individual projects will prove to be useful only if the results from a prior regional growth analysis are known. A number of estimated changes in certain parameters such as those dealing with technical advance which are important in formulating discount rates can only come from estimates derived from a regional development model. In effect, it is argued that the objective of multi-purpose water development projects should be explicitly cast in the context of promoting a maximum rate of regional economic growth. Sole reliance on the cost-benefit mode of analysis as demonstrated in the economic analysis carried out by the International Joint Commission is self defeating in both the aggregate (system evaluation) and individual sense (project evaluation) if the dynamic growth properties are ignored.

Areas for Further Development

The criticisms incorporated in this thesis have been largely of a negative rather than of a constructive nature.

These criticisms have clearly pointed out the great need for a positive economic approach to problems in the field of water resource economics. The International Joint Commission would appear to have been placed in the unfortunate position of attempting to formulate an economic framework designed to fit normative considerations which are beyond the realm of positive economics and normally relegated to the field of policy making. Clearly, this approach will not give policy makers the requisite economic guidance they require.

The employment of a constructive mode of criticism in the thesis would have placed the onus upon the writer to suggest or indicate the type of remedial action (alternative plans) which should be undertaken to correct certain lapses or gaps in portions of the economic analyses conducted by the various governments and agencies. This is beyond the scope of this thesis; however, there are three rather general comments which can be made and which suggest certain areas for investigation at a later date. First, it is evident that a theoretical construct labelled a natural resource development model needs to be formulated. It is suggested this would require an original piece of theoretical research. The basic question which must be answered by such a model would be given a natural resource inventory of a relatively sparsely settled area which is richly endowed in certain basic resources, what type of an investment program would

lead to the optimal utilization of these resources in such a manner as to insure the greatest rise in per capita income for the residents of that region. This requirement would involve formulating relationships between energy utilization requirements and the development of complementary natural resource orientated industries as well as estimates of the effect of technical change on capital and labour employed in primary manufacturing. In addition the concomitant need for social overhead capital provided by the various levels of government in promoting regional growth would require that governmental activities would need to be considered as endogenous variables in the model. It is evident that these few comments only serve as a tentative appraisal of some of the major requirements needed in such a model. It is equally evident that such a task would pose an enormous number of difficult theoretical problems.

As a second general comment it is suggested that an application of the existing tools of economic analysis could yield some fruitful results in attempting to evaluate the qualitative and quantitative aspects of the major economic trends involved in any regional development considerations. This would include tools of analysis ranging from regional input-output models to certain linear and non-linear programming approaches. From a quantitative point of view it would appear that none of these tools would be too well adapted towards casting much light on as complex a maze of problems

as those included in the development of the Columbia River basin (the restrictions of constant returns to scale and no indivisibilities would be particularly irksome).

The third comment encompasses both the previous comments in the sense that it is suggested that a natural resource center should be established to examine the complex theoretical and empirical problems involved in promoting the optimal utilization of Canada's natural resources. It is proposed that this body should be centered in a major university and funded by the provincial and federal governments. It is suggested that once a sufficiently large number of experts was collected that all provincial and federal projects in the field of natural resources should be required to undergo the economic appraisal of this relatively independent and hopefully, highly operational group. In the age of the computer and the expert in various fields the eventual economies derived from standardized statistical and economic modes of analysis carried out by a central body should result in a mass production of carefully analysed projects that would provide a higher degree of guidance to municipal, provincial and federal policy makers than is presently being achieved by the present ad hoc approaches.

It should be re-emphasized that the above comments are extremely general and in the spirit of the third comment they are also utopian in nature; however, it is evident that a vast amount of work is required in the foregoing general areas before any type of a serious approach can be taken

towards attempting to solve the problem of achieving an efficient allocation of Canada's natural resources.

As a final concluding remark it is felt that if any implication of substantial importance can be drawn from this thesis perhaps it rests in the observation that economic analyses and economists in general have an important role to fulfill in society. Their prime function is to provide the best possible analysis of the many alternative ways of allocating society's scarce resources. The final decision as to what ends these resources are allocated to rests in the hands of society as a whole. It is suggested that on the basis of the examination conducted in this thesis that neither economists or society (through its decision makers) could assume that any type of an optimal economic decision was reached with respect to the allocation of natural resources in the Columbia River basin.

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